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Galyna Nazarova, Alina Demianenko, Nikita Nazarov, Oleg Ivanisov, Vladyslav Ostapchuk

DETERMINANTS OF HUMAN POTENTIAL DEVELOPMENT IN THE CONDITIONS OF STRUCTURAL TRANSFORMATION OF INDUSTRY

The structural transformation of industry in Europe is accompanied by profound changes in the structure of employment. In these conditions, human development determines the ability of the economy to adapt, while demographic and migration processes form the underlying preconditions for industrial change. The research aims to determine the relationship between the HDI and a set of demographic and migration indicators. Their impact on key components of the HDI remain relevant in the face of structural transformation of industry. The following research methods were used in the article: descriptive statistics; statistical methods of determining the normality of data; correlation analysis was performed to determine the strength and direction of correlation; panel regression modeling allowed to identify significant results in the quantitative assessment of the influence of factors. The results of research obtained reveal statistically relationships between demographic and migration indicators and each dimension of the HDI. The correlation analysis identified the direction, strength, and closeness of associations between key variables. The results revealed a moderate degree of positive correlation between the Age dependency ratio and two dimensions of human development: Long and healthy life and Decent standard of living. The analysis showed a strong negative impact of the Crude Death Rate on almost all HDI dimensions. The Net migration rate has a significant positive impact on two areas of human development: Knowledge and Decent standard of living, as well as the HDI as a whole. Net migration rate and crude rate of immigration proved to be of particular interest for future research as compensating factors, the increase of which can accelerate HDI progress. The results of the correlation analysis showed the influence of other indicators on the HDI dimensions, but such influences were weak, nonlinear, or context-dependent. The regression analysis conducted for each dimension of human development provides practical insights of high policy relevance. The constructed models offer an empirical basis for identifying key influencing factors and enable forecasting, as well as the development of evidence-based strategies and targeted measures aimed at strengthening the resilience of human capital and human development under conditions of structural transformation of industry.

Keywords: human development; human development index; human capital; demographic dynamics; migration risks; structural transformation; industry.

1. Introduction

The structural transformation of industry in Europe is one of the key trends in today's economy. It is manifested in a gradual shift away from traditional industries and the simultaneous development of high-tech sectors, digital technologies, and green energy. These changes are shaping a new structure of employment and production processes, placing high demands on workers' qualifications and competencies.

Human development in such conditions becomes critically important: the population's ability to adapt to changes in the labor market, master new professions, and undergo retraining determines the economic and social stability of the state. The structural transformation of industry directly affects people's access to jobs, their income levels, and prospects for professional growth.

At the same time, demographic changes and migration processes serve as the root causes of these shifts: population aging, internal migration from depressed industrial regions to technological hubs, and the recruitment of skilled professionals from abroad are shaping a new labor force structure. It is precisely the combination of structural industrial transformation and demographic-migration processes that defines the current challenges and opportunities for human development in Europe.

2. Analysis of the literature and problem definition

The concept of human development has not lost its relevance over the past decades; on the contrary, it has gained even greater significance, depth, and a shift in emphasis, especially in conditions of high turbulence and unpredictability. Thus, contemporary societal development is characterized by non-linearity, uneven progress, and an integrated complex network of social, economic, political, environmental, and other factors; therefore, understanding the connections and interrelationships of these factors is extremely important for developing security policies and fostering the strategic sustainability of human development. This is precisely

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why the total number of studies dedicated to identifying the connection between socio-economic processes has significantly increased in recent years, including research on the impact of demographic and migration processes on human development.

V. Lutz and S. Kumar K. S. (2013) examined fundamental questions regarding the acceleration of human development through the lens of demographic transition processes [1]. As a result of in-depth research, the scholars obtained valuable findings regarding the conditions that can influence the acceleration of certain components of human development. These conditions include a decrease in the dependency ratio of the young population (a certain number of adults must support a smaller number of children) and improvements in educational infrastructure. Investment in education is a key factor influencing changes in population structure: a decline in fertility and the emergence of the demographic dividend effect, which has a strong impact on economic growth. The established patterns and causal relationships between demographic aspects, the population's level of education, and economic growth have broadened our understanding of the human development process, confirmed the primary causality of human capital as a driver of human potential development, and served as a starting point for future research [1–4].

The results of the analysis of scientific studies conducted by researchers confirm the importance of demographic factors for human development. Hartgen and Vollmer (2014) examine the relationship between human development and fertility using a modified HDI [5]. The analysis demonstrates that the so-called fertility transition effect is not stable and varies depending on the HDI level, emphasizing that the observed links between demographic and development indicators may be unstable and highly sensitive to methodological choices.

Our attention was drawn to a study by Kozlovsky S., Pasichny M., Lavrov R., Ivanyuta N., and Nepitalyuk A. (2020). The researchers' aim was to identify relationships between changes in demographic variables (growth rates of the working-age population and average life expectancy) and economic growth. The researchers established a close link between life expectancy and nominal GDP per capita. Life expectancy was significantly higher in developed countries than in developing countries; the researchers also found that growth in the working-age population drastically reduced production dynamics, but this relationship was not stable [6,7].

Bafail and Alamudi (2023) determined that the following indicators – the share of skilled labor, R&D expenditure, tourism expenditure, and trade expenditure – are the most influential determinants of the HDI, using multiple regression to rank their relative importance [8]. Sing et al. (2025) confirmed that GDP per capita, average years of schooling, and infant mortality are key determinants of HDI, explaining approximately 95% of its variation [9].

Although most empirical studies focus on assessing the impact of demographic dynamics on economic and social outcomes, other researchers (Errero, Martinez, and Villar, 2019) emphasize that demographic composition itself can distort development measurements [10–13]. Research by these scholars has shown that the traditional HDI (developed by UNDP experts) does not fully reflect the actual level of human well-being, as it does not account for the age structure of the population.

Over the past few decades, researchers worldwide have been studying issues of demographic and human development and their interrelationships, and each year new valuable scientific findings emerge, the implementation and practical application of which can expand human potential and influence the pace and scale of human development. Previous studies in this field are characterized by diverse regional samples. When examining the impact and interrelationship between human development and demographic processes, some researchers focus on specific aspects or within the framework of their own understanding of human development, rather than the generally accepted methodology for measuring human development levels developed by UNDP experts. In our study, we examine the impact of demographic and migration factors on the HDI in 12 EU countries with specific demographic and/or migration challenges. This will provide a clearer and more vivid picture of the depth of the impact, revealing regional imbalances and sources of vulnerability. In addition, the extent and nature of these factors' impact are examined for each structural component of the HDI according to the UNDP measurement model.

Thus, this article examines the theoretical, methodological, and practical aspects of human development shaped by demographic and migration factors. The aim of the study is to determine the relationship between the HDI and a set of demographic and migration indicators. Their impact on key HDI

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components remains relevant in the context of growing instability and uncertainty.

The results of our study have both theoretical and practical value. The theoretical contribution lies in identifying consistent patterns, substantiating a model of causal relationships between processes, and establishing a theoretical framework for forecasting each component of the HDI. The practical value lies in the developed regression model, which allows predicting how the level of each HDI component will change under the influence of demographic factors (changes in the age structure of the population, changes in mortality and fertility rates, etc.) and migration factors (changes in immigration and emigration levels).

3. Purpose and Objectives of the Study

The purpose of the study is to determine the relationship between the HDI and a set of demographic and migration indicators, as their impact on key HDI dimensions remains a relevant issue in the context of industrial structural transformation.

The objectives of the study are as follows:

1) to analyze differences in human capital development, demographic, and migration situations among the countries under study;

2) to justify the feasibility and relevance of using the selected indicators for further research;

3) to identify promising and significant results in the quantitative assessment of the impact of factors on each component of the HDI.

4. Methodology

The study is based on assessing the impact of a set of independent variables (demographic and migration-related) on each component (element) of the HDI. To achieve the set goal, multiple regression analysis methods were applied.

The Human Development Index is a complex composite indicator that combines components reflecting various aspects of human development ("Long and Healthy Life", "Knowledge", "Decent Standard of Living"). Each of these components is shaped by various socioeconomic, demographic, migration, and other factors, which makes the construction of a single regression model for the aggregate HDI methodologically limited.

First, demographic and migration factors exert a similar nature and direction of influence on the aggregate HDI. Assessing the impact of demographic and migration factors on the aggregate HDI leads to an averaging of dependencies and a loss of information about the effects on individual components.

Second, HDI components differ in measurement scale and time sensitivity.

Third, HDI components have varying significance, although the UNDP model's HDI calculation methodology involves normalization and aggregation to ensure their comparability and equal weight in the overall index. However, in models with an aggregated composite indicator, it is impossible to unambiguously determine which specific component is responsible for a change in the HDI. Modeling individual HDI components makes it possible to identify a set of demographic and migration factors that significantly influence each HDI component, which enhances the analytical significance of the results and their practical innovation for the development of socio-demographic policy.

Fourth, this approach partially mitigates the problem of endogeneity. Demographic and migration indicators and the HDI may be in a reciprocal causal relationship, yet endogeneity manifests differently for individual components.

Thus, the methodology of studying individual HDI components aligns with the structural logic of human development, within which demographic and migration factors influence both individual components ("Long and Healthy Life", "Knowledge", "Decent Standard of Living") and the overall HDI.

The chosen methodological approach corresponds to the study's objective and the scientific tasks set forth and involves testing the hypotheses formulated by the authors.

Hypothesis 1. The impact of demographic and migration factors on HDI components is statistically heterogeneous, indicating varying intensities of their effects on individual components.

Hypothesis 2. The impact of demographic and migration factors on each component of the HDI can be assessed using a separate regression model, which allows for identifying the specific nature of the impact of individual independent variables (demographic and migration) on each component.

The study utilized general scientific and specialized research methods. Statistical and mathematical methods:

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graphical, correlation, and panel regression analysis to identify relationships and construct a mathematical model. Descriptive statistics provided an initial understanding of differences in human capital development, demographic and migration situations across countries, and allowed us to draw conclusions regarding the potential use of certain indicators for further research. A correlation analysis was conducted to determine the strength and direction of the correlation. The use of panel regression modeling allowed us to identify promising and significant results in the quantitative assessment of the impact of factors on each component of the HDI.

Selection of indicators and data analysis. Statistical data on the HDI and primary indicators were obtained from the UNDP Human Development Data Center. The selection of independent variables for multiple regression analysis was determined by several factors. First, we used statistical data on demographic and migration indicators for EU countries obtained from the official Eurostat website, which ensured comparability of indicators across countries and throughout the study period. Second, we selected indicators that demonstrated changes over time, allowing us to assess the dynamics of the processes under study. Third, the statistical data on the selected demographic and migration indicators most clearly reflect the key demographic and migration issues under study, and their significance is characteristic of most of the countries included in the analysis. Thus, the selection of variables was based simultaneously on data availability, their dynamics, and theoretical relevance to the evaluation process.

Our study utilized modern software tools for data processing and analysis, such as SPSS Statistics and Microsoft Excel.

The study analyzed statistical data from 12 EU countries (Bulgaria, the Czech Republic, Denmark, France, Germany, Greece, Italy, Latvia, Lithuania, Poland, Romania, Sweden) that experience varying degrees of demographic or migration challenges but have a high or above-average HDI. It makes sense to include Ukraine in the main study sample – a country characterized by a unique case of an exogenous factor causing a sharp demographic and migration shock, in addition to other demographic and migration challenges (low birth rates, high mortality, demographic distortion, and labor emigration). However, since Ukraine is not currently an EU member, and given that the publication of certain demographic and migration data is restricted due to wartime conditions and security concerns, including Ukraine in the model is not currently possible. Nevertheless, the model developed using data from the aforementioned European countries can be adapted for forecasting and strategic planning purposes in Ukraine.

5. Research Results

The primary indicator of human development is the HDI, developed by UNDP experts. Although the HDI has a number of strengths and weaknesses regarding its set of indicators, the objective determination of its level, and its sensitivity to internal and external changes, the HDI remains the key measure of countries' achievements in creating conditions that promote the expansion of human capabilities. The HDI is the indicator of global well-being in the modern world and, at the same time, a tool for shaping and reforming the policies of many states [14]. The results of the analysis of global HDI trends reveal interesting patterns. One such trend is the general, steady increase in the level of human development worldwide (Fig. 1).

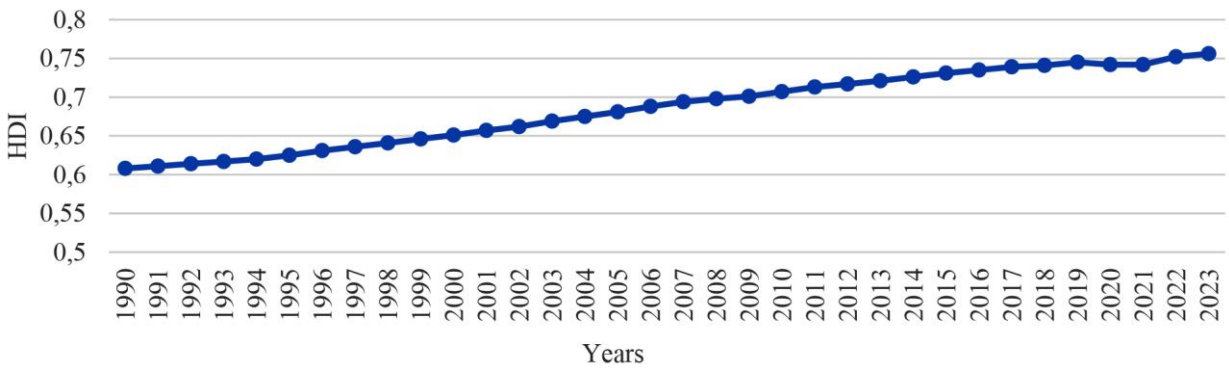

Fig. 1. Trends in the global HDI [15]

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The steady rise in global human development can be attributed to a number of factors: the long-term trend toward improved living standards; the irreversibility of certain processes; the structure of the index; and so on. However, the pace of this growth varies by region and over the study periods, depending on the extent and intensity of the influence of internal and external factors. Thus, there are a number of processes capable of influencing fluctuations in the index: stimulating or hindering development; the impact of these processes on the HDI can be either direct or indirect.

The results of the data analysis demonstrate a similar trend of rising HDI levels in the EU countries included in the analysis. It should be noted that in all countries included in the analysis, the HDI level is higher than the global average (Fig. 2).

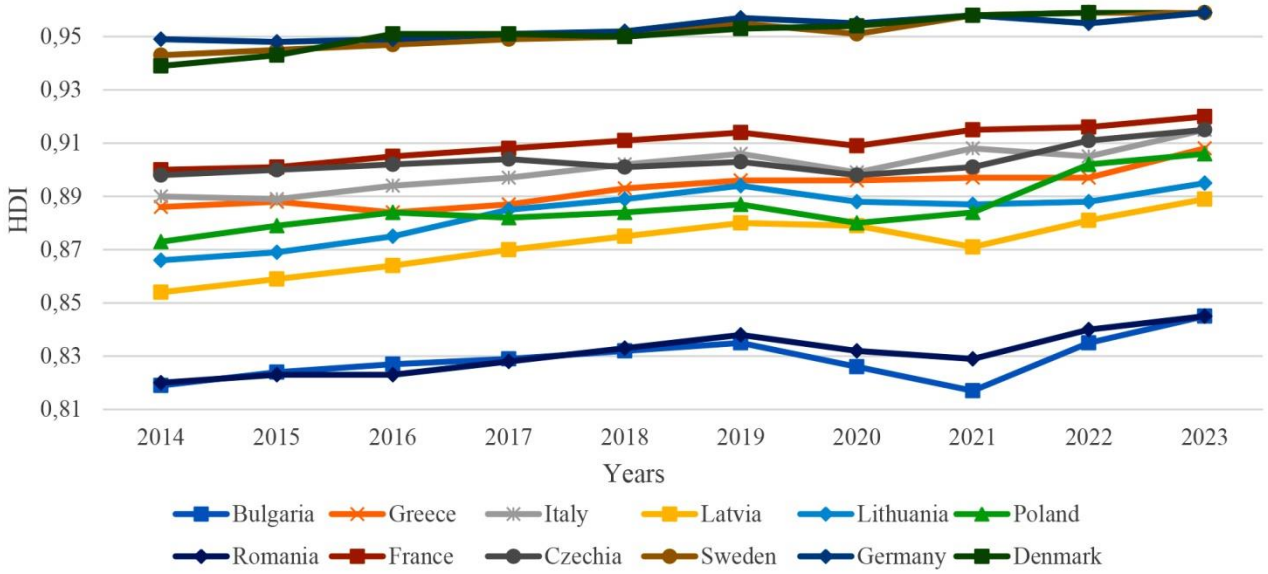

Fig. 2. HDI trends in some European countries [15]

As shown in Fig. 2, the HDI trajectory of almost every country is unstable and subject to slight fluctuations, and the dynamics reveal a slowdown in the growth rates of the HDI of the studied countries compared to the global HDI. Such fluctuations and the slowdown in HDI growth are caused by a series of processes that can stimulate, reduce, or hinder development, and the impact of these processes on the HDI can be direct or indirect, nonlinear, or context-dependent. One group of such factors consists of demographic and migration processes. Their distinctive feature lies in their contribution to the formation of human capital: demographic and migration processes determine the scale and quality of human resources and alter the trajectory of development in the long term.

It should be noted that the EU countries selected for the study face demographic and/or migration challenges to varying degrees. Therefore, the methodology for selecting countries was based on their analytical grouping according to the intensity of these factors. Three groups were conditionally identified. The first group included countries with significant negative demographic and migration problems (Bulgaria, Lithuania, Latvia, and Italy). The demographic situation in these countries was characterized by a combination of low birth rates, accelerated population aging, and depopulation. The second group of countries – Poland, Romania, and Greece – was characterized by moderate demographic and migration challenges. The third group of countries included the Czech Republic, Denmark, Germany, France, and Sweden. The migration situation in these countries was relatively stable; there was an issue of population aging, which was also not critical and was mitigated by compensating factors. In our opinion, including countries with varying degrees of demographic and migration challenges will ensure objective research results. An analysis of key trends was conducted in the aforementioned countries. As a result of the comparative analysis, key patterns and cause-and-effect relationships were identified.

Based on a thorough analysis of the dynamics of the Age Dependency Ratio, it can be concluded that the indicator increased by an average of 10–12%, reflecting the intensification of the population aging trend and a decline in fertility. The largest increases were observed in Poland, Bulgaria, and Romania,

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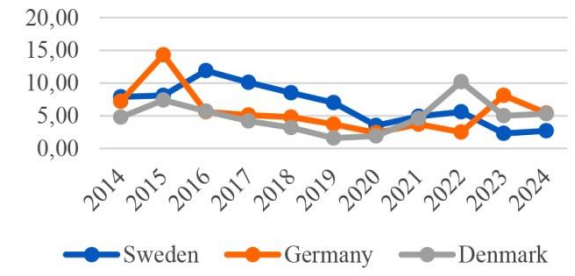
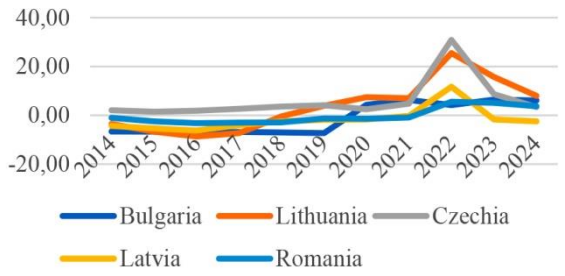
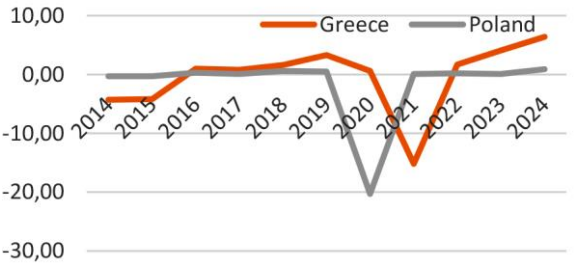
indicating an acceleration of demographic dependency and a decline in the working-age population. France, Sweden, and Denmark showed relatively stable but high rates (around 60–62%). These rates are typical of a demographic model with balanced life expectancy and fertility.



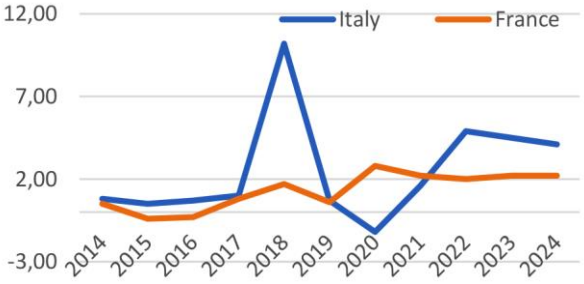
Group A. Sustained, rapid population growth



Group B. A sh arp increase in migration levels after 2019



Group C: Sharp drops and virtually no fluctuations



Group D. Strong positive fluctuations

Fig. 3. Total adjusted net migration in selected EU countries, 2014–2024 [16]

Grouping countries and identifying trajectories provide a deeper understanding of the patterns and underlying factors driving these trends. This will enable an objective and high-quality implementation of the correlation analysis procedure.

After identifying the demographic and migration trends of the countries included in the analysis, the authors conducted a correlation analysis. This stage of the study involved identifying and interpreting potential interdependencies between variables, providing a conceptual and empirical basis for further quantitative modeling of the impact of demographic and migration factors on human development (Table 1).

Table 1. *Descriptive statistics for the primary HDI indicators and demographic and migration indicators*

Indicator	Average meaning	Median	Mode	Minimum value	Maximum value	Standard deviation	Assimetry	Excess
Y	0,90	0,90	–	0,82	0,96	0,041	–0,175	–0,741
Y_1	0,91	0,92	0,97	0,79	0,98	0,051	–0,285	–1,412
Y_2	0,82	0,84	–	0,68	0,95	0,073	–0,120	–1,086
Y_3	0,93	0,92	–	0,78	1,16	0,081	0,568	–0,076
Y_4	0,92	0,92	–	0,82	1,00	0,046	–0,007	–1,089
X_1	55,12	55,75	57,40	42,70	62,20	4,025	–0,627	0,344
X_2	31,29	31,60	–	21,20	37,80	3,320	–0,466	0,395
X_3	1,58	1,60	1,70	1,20	2,00	0,198	–0,147	–0,860
X_4	12,12	11,35	9,10	8,40	22,90	2,694	1,000	1,181
X_5	1,97	1,70	–	–20,30	30,90	6,347	0,735	5,232
X_6	6,70	5,87	–	1,01	19,44	3,621	1,024	1,286
X_7	9,31	7,69	–	2,81	33,04	5,324	1,859	4,751

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The HDI shows a high average score of 0.90, indicating a high level of human development with low dispersion and a nearly symmetrical distribution, suggesting relatively uniform development outcomes across countries. The "Life Expectancy at Birth" indicator and the indicators of the "Knowledge" sub-index reflect similar stability. The "Decent Standard of Living" sub-index, measured using Gross National Income per capita, is characterized by greater variability, reflecting significant differences in income levels among countries.

A preliminary analysis of the skewness and kurtosis coefficients showed that most indicators had values close to a normal distribution. However, some variables were characterized by pronounced positive skewness and high kurtosis, indicating a deviation from the norm.

To more accurately verify the data distribution, additional normality tests were conducted using the Shapiro–Wilk (W) and Kolmogorov–Smirnov (K–S) tests (Table 2).

Table 2. *Normal distribution test results*

Indicator	Shapiro–Wilk W	Sig.(SW)	K–S D	Sig. (K–S)	Interpretation
Y	0,938	0	0,110	<0,15	Abnormal distribution
Y_1	0,899	0	0,181	<0,01	Abnormal distribution
Y_2	0,944	0	0,143	<0,05	Abnormal distribution
Y_3	0,941	0	0,152	<0,01	Abnormal distribution
Y_4	0,960	0	0,097	> 0,20	Abnormal distribution
X_1	0,970	0,01	0,078	> 0,20	Close to normal
X_2	0,982	0,11	0,054	> 0,20	Normal distribution
X_3	0,954	0	0,1385	<0,05	Abnormal distribution
X_4	0,923	0	0,119	<0,10	Abnormal distribution
X_5	0,916	0	0,103	<0,20	Abnormal distribution
X_6	0,928	0	0,105	<0,15	Abnormal distribution
X_7	0,833	0	0,146	<0,05	Abnormal distribution

According to the results of the normality test, most variables showed significant or severe deviations from the normal distribution, indicating that their data were non-normally distributed. Only variables X_1 and X_2 exhibited approximately normal and normal distributions, respectively. Thus, the overall data structure did not conform to a normal distribution, so it was decided to apply nonparametric statistical methods in the subsequent analysis.

In this regard, nonparametric methods were applied, specifically Spearman's rank correlation coefficient (ρ) and Kendall's tau coefficient (τ), which do not require an assumption of data normality (Table 2).

Table 3 presents the results of the correlation analysis between dependent and independent variables. The simultaneous use of Spearman's ρ and Kendall's τ coefficients is due to the complex and difficult-to-formalize nature of the analyzed relationships. Their simultaneous application allows for distinguishing between structural and proportional dependencies and provides a more robust interpretation of correlations in the context of heterogeneous data.

The results obtained indicate a diversified system of interrelationships characterized by both direct and inverse dependencies of varying strength. The consistency between Spearman's and Kendall's coefficients confirms the stability of the identified relationships and suggests that these relationships are not random.

The age dependency coefficient has a direct positive impact on certain sub-indices of human development, namely Life Expectancy at Birth and Gross National Income per Capita.

The old-age dependency ratio maintains a moderate positive relationship with the HDI overall and with life expectancy at birth, which may indicate that its influence is conditional or secondary, mediated through other components of the system.

The total fertility rate shows mostly minor but negative correlations. We hypothesize that such a correlation is nonlinear or context-dependent, a view supported by a number of studies by researchers.

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Table 3. *Correlation matrix of demographic and migration indicators and HDI measures*

Indicators	Y	Y_1	Y_2	Y_3	Y_4
X_1	$\rho =$ 0,432 $\tau =$ 0,309	$\rho = 0{,}538$ $\tau = 0{,}399$	$\rho = -0{,}195$ $\tau = -0{,}093$	$\rho = 0{,}238$ $\tau = 0{,}178$	$\rho = 0{,}397$ $\tau = 0{,}292$
X_2	$\rho = 0{,}256$ $\tau = 0{,}194$	$\rho = 0{,}392$ $\tau = 0{,}280$	$\rho = -0{,}231$ $\tau = -0{,}121$	$\rho = 0{,}249$ $\tau = 0{,}173$	$\rho = 0{,}150$ $\tau = 0{,}130$
X_3	$\rho = -0{,}005$ $\tau = -0{,}047$	$\rho = -0{,}076$ $\tau = -0{,}064$	$\rho = -0{,}086$ $\tau = -0{,}110$	$\rho = -0{,}303$ $\tau = -0{,}218$	$\rho = 0{,}132$ $\tau = 0{,}073$
X_4	$\rho = -0{,}726$ $\tau = -0{,}518$	$\rho = -0{,}818$ $\tau = -0{,}619$	$\rho = 0{,}098$ $\tau = 0{,}102$	$\rho = -0{,}413$ $\tau = -0{,}285$	$\rho = -0{,}671$ $\tau = -0{,}471$
X_5	$\rho = 0{,}611$ $\tau = 0{,}456$	$\rho = 0{,}383$ $\tau = 0{,}262$	$\rho = 0{,}262$ $\tau = 0{,}174$	$\rho = 0{,}418$ $\tau = 0{,}287$	$\rho = 0{,}617$ $\tau = 0{,}436$
X_6	$\rho = -0{,}209$ $\tau = -0{,}121$	$\rho = -0{,}381$ $\tau = -0{,}267$	$\rho = 0{,}225$ $\tau = 0{,}158$	$\rho = 0{,}109$ $\tau = 0{,}074$	$\rho = -0{,}160$ $\tau = -0{,}065$
X_7	$\rho = 0{,}379$ $\tau = 0{,}251$	$\rho = 0{,}043$ $\tau = 0{,}028$	$\rho = 0{,}423$ $\tau = 0{,}289$	$\rho = 0{,}414$ $\tau = 0{,}265$	$\rho = 0{,}428$ $\tau = 0{,}294$

Notes:
ρ – Spearman's rank correlation coefficient; τ – Kendall's rank correlation coefficient.

Among the most pronounced negative relationships is the link between the mortality rate and life expectancy at birth. Spearman's correlation coefficient indicates a very high, nearly perfect relationship. Thus, the high mortality rate observed in the countries included in the analysis significantly lowers the life expectancy at birth. This relationship warrants attention, as the trend is specific and may result from changes in the age structure of the population due to the emigration of young people or high mortality rates among this demographic. This implies the emergence of an economic effect and the existence of another strong inverse relationship between mortality rates and gross national income per capita.

Net migration showed a strong positive correlation with both the HDI overall and some of its components: expected years of schooling and gross national income per capita, underscoring that in the countries studied, net migration acts as a compensatory (stimulating) factor. There is a weak negative correlation between the total emigration rate and life expectancy at birth.

The total immigration rate has a moderate positive correlation with three HDI indicators. Thus, an increase in the total immigration rate leads to an increase in the average and expected years of schooling. In our view, this relationship may be driven by a chain of interrelated processes. This increase may be caused by an influx of children and youth, which stimulates demand for education and necessitates the expansion of educational programs, as well as the prolongation of educational trajectories due to adaptation. Another scenario for the increase in the duration of schooling due to immigration could be institutional integration measures. Thus, educational immigration or relocation for the purpose of active integration into a new society increases the duration of schooling.

In light of the above, it should be noted that the results of the correlation analysis confirm asymmetric and disproportionate interdependencies, where certain factors (Age Dependency Ratio, Net Migration Rate, and Immigration Rate) have a dominant influence, while others (Mortality Coefficient and Emigration Coefficient) create a balancing effect. This fact underscores the need for a multidimensional model capable of accounting for both reinforcing and inhibiting dynamics for each HDI component.

The identified correlation structure provides an empirical basis for the next stage of analysis. Given the difficult-to-formalize and complex nature of human development, as well as the multidimensional structure of the HDI and the heterogeneity of the mechanisms underlying its formation, it is appropriate to use a differentiated approach. This is precisely what necessitates the construction of several regression models focused on individual structural components of the HDI.

Constructing three models with sub-indices as dependent variables allows us to:

– avoid the "averaging" effect of influences;

– increase the accuracy of coefficient estimates;

– reduce the risk of methodological distortions associated with excessive data aggregation.

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Each of the three regression models reflects a separate aspect of human development and allows for the conceptualization of the mechanisms underlying its formation:

– the first model characterizes the influence of demographic and migration factors on the longevity component of human development;

– the second model reflects the dependence of the educational component on the quality of demographic and migration policies;

– the third model focuses on productivity potential and the economic realization of human potential.

This approach deepens the theoretical understanding of human development as a multidimensional process and confirms that its components have different sensitivities to demographic and migration determinants.

In our study, nonparametric data were used for modeling. A check of the sample for multicollinearity revealed a high degree of dependence among the independent variables. High VIF values were observed for the Age Dependency Ratio and the Elderly Dependency Ratio, indicating a significant level of multicollinearity. Both indicators reflect related aspects, leading to information redundancy in the models (Table 4).

Table 4. *Assessment of multicollinearity*

Indicator	VIF	Interpretation
X_1	5.474	High multicollinearity
X_2	5.396	High multicollinearity
X_3	1.965	Acceptable level
X_4	1.589	Acceptable level
X_5	4.188	Acceptable level
X_6	2.386	Acceptable level
X_7	4.221	Acceptable level

The net migration rate and the immigration rate also show marginal multicollinearity, whereas the net migration rate, the emigration rate, and the immigration rate reflect similar processes. Therefore, some independent variables were excluded to remove redundant information from the model. A subsequent VIF calculation confirmed a significant reduction in multicollinearity and stabilization of the coefficient estimates. Thus, the model retains only those variables (Age-Dependency Coefficient, Total Fertility Rate, Mortality Rate, Emigration Rate, and Immigration Rate) that provide unique information, thereby enhancing the reliability of the results' interpretation.

Each dependent variable – each HDI sub-index – is modeled as a function of demographic and migration variables using rank-order multiple regression. This approach allows for the capture of nonlinear and distribution-invariant relationships between demographic and migration factors (Age-Dependency Coefficient, Total Fertility Rate, Mortality Rate, Emigration Rate, and Immigration Rate) and the human development sub-indices $(Y_L,\ Y_k,\ Y_D)$. The construction of three models allows for a comparative analysis of the strength, direction, and statistical significance of the impact of demographic and migration factors on various components of human development. This makes it possible to:

– identify key determinants for each sub-index;

– identify asymmetries in the effects;

– form a more detailed empirical basis for further research.

Model 1. Demographic and migration determinants of the "Long and Healthy Life" sub-index. The regression model demonstrated adequacy. The coefficient of determination was 0.86, and the adjusted coefficient of determination was 0.85, indicating that the model explains a significant portion of the variance in the dependent variable. The high F-value (5, 114) = 176.65 indicates that the entire model is statistically significant and adequately explains the variance of the dependent variable. The SEE was 13, indicating acceptable accuracy. It is worth noting that the General Immigration Level indicator was excluded from the model due to its statistical insignificance $(p > 0.05)$, which improved the interpretability of the regression equation.

$$Y_L = 106,2 + 0,379 \times X_1 - 0,311 \times X_3 - 0,73 \times X_4 - 0,089 \times X_6 + \varepsilon. \quad (1)$$

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Model 2. Demographic and migration determinants of the "Knowledge" sub-index. The multiple regression model, which includes three variables, is statistically significant, as $F(5,\ 114) = 24.34$, $p < 0.001$. $R^2 = 0.38$, adjusted $R^2 = 0.37$.

These results indicate the acceptable quality of the model and its ability to explain 38% of the variation in the dependent variable, which is sufficient for this HDI measure. To optimize the model, the "Overall Emigration Rate" variable was excluded, as it had no significant effect on Y_k

$$Y_K = 59{,}99 - 0{,}18 \times X_3 - 0{,}28 \times X_4 + 0{,}515 \times X_7 + \varepsilon . \quad (2)$$

Model 3. Demographic and migration determinants of the "Decent Standard of Living" subindex. Four significant variables were used to construct the model (the total fertility rate was excluded due to its non-significant p-value). The results of the analysis showed that the model explains approximately 65% of the variation in the dependent variable, and the adjusted R^2 confirmed the model's adequacy. $F(5,\ 114) = 54.39$ indicates the overall significance of the model. The standard errors of the coefficients are at an acceptable level.

$$Y_d = 69{,}9 + 0{,}126 \times X_1 - 0{,}55 \times X_4 - 0{,}2 \times X_6 + 0{,}47 \times X_7 + \varepsilon . \quad (3)$$

Thus, the data obtained from the model-building process demonstrate that the models are sufficiently adequate for further application.

From a practical standpoint, the proposed approach offers significant advantages for the development and implementation of public policy. Focusing on sub-indices allows for the formulation of targeted policy decisions aimed at specific problem areas of human development, rather than universal but less effective measures. The results obtained can be used:

– in the formulation of educational and social policy;

– in the healthcare sector;

– in the development of strategies for human capital development and employment.

Thus, the use of three regression models instead of a single generalized one not only eliminates the methodological limitations of existing approaches but also ensures a deeper theoretical understanding and high practical significance of the research results.

6. Discussion of Results

This section interprets the results of the correlation and panel regression analyses, highlighting the main relationships between explanatory variables and dependent variables. The results obtained and the conclusions drawn by the authors are analyzed and substantiated in light of the existing scientific literature on the subject and their significance for policy and practice.

Correlation analysis showed that the positive relationship between the demographic dependency ratio and life expectancy at birth, as well as per capita GNI, may reflect the characteristics of the demographic transition. In more economically developed countries, high life expectancy leads to an increase in the proportion of the elderly population, which raises the overall dependency ratio. At the same time, high GDP per capita provides the resources to support dependent age groups thanks to well-developed health care, education, and social security systems. Thus, a high age dependency ratio in this case is not a consequence of economic weakness but an indicator of demographic aging.

As correlation analysis has shown, the fertility rate has a negligible impact on HDI components, and this impact depends on the context, as confirmed by studies conducted by researchers who have examined this issue. However, a weak negative correlation is observed between the fertility rate and expected years of schooling. Therefore, we hypothesize that an excessively low fertility rate creates a demographic imbalance that indirectly reduces the level of expected years of schooling. Thus, the conclusion of Hartgen and Wallmer (2014) regarding the complex bidirectional interaction between fertility and HDI components is confirmed, according to which both excessive and insufficient fertility can hinder human development [7].

Mortality rates have a strong negative impact on life expectancy and health, as well as on a decent standard of living, indicating the inhibitory effect of sociodemographic characteristics. High mortality rates shorten life expectancy, as the proportion of young and working-age people in the population structure changes for various reasons: this may be due to their outflow from the country, mortality, or a decline in the youth (or working-age) segment

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of the population as a result of demographic decline. At the same time, this reduces the size and productivity of the labor force, increases social expenditures, and decreases national income. Therefore, a high mortality rate is an indicator of a low level of development of the healthcare system and the country's limited economic potential.

The net migration rate has a strong positive impact on all human development sub-indices. Migration is typically accompanied by an influx of economically active, well-educated individuals of working age, thereby strengthening the country's human capital. This contributes to increased labor productivity, the development of innovation, and the improvement of health and education systems. In addition, migrants often bring additional financial resources, such as investments, taxes, and remittances, which stimulate economic growth. Thus, a positive net migration rate is a factor in demographic and economic renewal, contributing to increased well-being and socio-economic stability in the country.

The overall level of emigration has a negative impact on the HDI. However, this impact is weak and insignificant. It is important to highlight the positive average impact of immigration on the levels of certain HDI components. This is particularly true for Average Years of Schooling, Expected Years of Schooling, and Gross National Income per Capita.

High levels of immigration, particularly of young and economically active individuals, lead to an increase in the labor force and higher labor productivity. This contributes to economic growth and increases national income. Furthermore, the influx of intellectual capital improves the quality of health care and education systems, which can enhance living conditions and the level of social security. As a result, high levels of immigration are a favorable factor for both education and a country's economic development.

The empirical results of our study further confirm and refine previous research, highlighting the significant impact of demographic factors on the HDI. As shown by studies by Lutz (2013) and Lutz et al. (2018), population structure, fertility, and mortality correlate with HDI components, which is consistent with our data on the positive impact of the working-age population share and the negative impact of high mortality rates [1; 2]. Empirical data from Kozlovsky et al. (2020), Engelhardt-Wolffler et al. (2018), and Herrero et al. (2019) show that age structure alters HDI dynamics, which is consistent with our study results [4]. The nonlinear effects described by Hartgen and Volmer (2012, 2014) explain the inverse effect of fertility on the HDI in countries at different levels of development [6, 7].

The models developed by the authors, based on data from European countries, have high analytical value, as they reflect generalized patterns of interrelationships between demographic, social, and economic factors of development. Ukraine belongs to the European socio-demographic space, so its human development dynamics are subject to similar structural trends – population aging, declining fertility, the impact of migration, and educational transformation. This makes the use of European models for forecasting methodologically justified, but with due consideration for Ukrainian conditions and the demographic and migration shock of 2022. Therefore, an adapted model, built on European patterns but parameterized using Ukrainian data, is capable of providing realistic forecasts of the components of human development in Ukraine.

7. Conclusions

The study results showed that the impact of demographic and migration factors on HDI components is heterogeneous. For the "Long and Healthy Life" dimension, the mortality rate is the determining factor, while a higher proportion of the working-age population and rising birth rates have a positive impact. For the "Knowledge" dimension, the level of immigration plays a dominant role (young people likely predominate in the immigration structure); The total fertility rate has a minor but significant impact on the reduction in the duration of education due to demographic aging and the redistribution of resources; it is worth emphasizing that demographic indicators have a context-dependent relationship. For the "Decent Standard of Living" measurement model, the most important factors are Mortality Rate and Net Migration Flow, which determine economic dynamics and development potential. Thus, the results obtained deepen the understanding of the interrelationship between demographic processes, migration, and the level of human development. The constructed panel regression models allow for a quantitative assessment of the contribution of each demographic and migration indicator to the formation of HDI components, providing a new empirical toolkit for analysis. Thus, the study contributes to the development of human development theory by elucidating the role of structural demographic changes as determinants of socio-economic dynamics.

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Scientific novelty of the study

The methodological approach to identifying the determinants of human capital development in the context of industrial structural transformation has been further developed. This approach is based on the construction of three regression models, where the dependent variables are the sub-indices of the Human Development Index, and the independent variables are demographic and migration factors represented by corresponding indicators. Unlike existing approaches, the proposed methodology focuses not on the analysis of the overall composite indicator (HDI), but on its structural components, which allows for the elimination of a number of limitations inherent in traditional models, enhances the analytical and statistical significance of the results, and ensures their practical value for the formulation and implementation of countries' socio-economic policies.

Directions for future research

Prospects for further research include the development of strategic programs and practical recommendations for demographic and migration policy in the context of improving human development, taking into account the identified dependencies. It also includes the development of methodological recommendations for forecasting the HDI, taking into account the impact of demographic and migration aspects. In our opinion, the study of the impact of the quantitative and qualitative characteristics of human capital migration as a compensatory factor for a country's human development in the context of global and local upheavals is of significant interest.

Conflict of interest

The authors declare that they have no conflicts of interest, including financial, personal, authorial, or any other nature, that could influence the research or the results published in this article.

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The manuscript has no associated data.

Use of artificial intelligence

The authors confirm that they did not use artificial intelligence technologies to write this paper.

References

1. Lutz, W. and Samir, K.C. (2013), *Demography and Human Development: Education and Population Projections*, United Nations Development Programme, New York, available at: https://hdr.undp.org/system/files/documents/hdro1304lutzkc.pdf (accessed 16 April 2026).
2. Lutz, W., Goujon, A., Samir, K.C., Stonawski, M. and Stilianakis, N. (2018), *Demographic and Human Capital Scenarios for the 21st Century: 2018 Assessment for 201 Countries*, IIASA, Laxenburg, 594 p. DOI: https://doi.org/10.2760/835878
3. Caselles, A., Soler Fernandez, D., Sanz, M. and Mico, J. (2014), "Simulating Demography and Human Development Dynamics", *Cybernetics and Systems*, Vol. 45, No. 6, pp. 465–485. DOI: https://doi.org/10.1080/01969722.2014.929347
4. Kozlovskyi, S., Pasichnyi, M., Lavrov, R., Ivanyuta, N. and Nepytaliuk, A. (2020), "An Empirical Study of the Effects of Demographic Factors on Economic Growth in Advanced and Developing Countries", *Comparative Economic Research*, Vol. 23, No. 4, pp. 45–67. DOI: https://doi.org/10.18778/1508-2008.23.27
5. Engelhardt-Wölfler, H., Schulz, F. and Büyükkeçeci, Z. (2018), *Demographic and Human Development in the Middle East and North Africa*, *Population and Family Studies*, Vol. 2, University of Bamberg Press, Bamberg, 88 p. DOI: https://doi.org/10.20378/irbo-50993
6. Stafeckis, N. and Berzins, M. (2026), "Exploring the Complex Interplay of Demographic and Socioeconomic Dynamics in Urban Shrinkage of Latvian Mono-Towns", *Urban Science*, Vol. 10, No. 4, Article 211. DOI: https://doi.org/10.3390/urbansci10040211
7. Harttgen, K. and Vollmer, S. (2014), "A Reversal in the Relationship of Human Development with Fertility?", *Demography*, Vol. 51, No. 1, pp. 173–184. DOI: https://doi.org/10.1007/s13524-013-0252-y
8. Tutar, H., Mutlu, H.T. and Streimikiene, D. (2025), "Rethinking Sustainable Development: Multidimensional Comparisons Across Countries and Regions", *Sustainable Development*, Vol. 34, Suppl. 1, pp. 183–196. DOI: https://doi.org/10.1002/sd.70157
9. Singh, K., Sharma, P. and Gupta, R. (2025), "Determinants of Human Development Index: A Regression Analysis of Economic and Social Indicators", *Asian Journal of Economics, Business and Accounting*, Vol. 25, No. 11, pp. 1–12. DOI: https://doi.org/10.9734/ajeba/2025/v25i11630

ISSN 2522-9818 (print) Сучасний стан наукових досліджень та технологій в промисловості. 2026. № 2 (36)
ISSN 2524-2296 (online) Innovative technologies and scientific solutions for industries. 2026. No. 2 (36)

10. Herrero, C., Martínez, R. and Villar, A. (2019), "Population Structure and the Human Development Index", *Social Indicators Research*, Vol. 141, pp. 731–763. DOI: https://doi.org/10.1007/s11205-018-1852-0
11. Hair, J.F., Black, W.C., Babin, B.J. and Anderson, R.E. (2019), *Multivariate Data Analysis*, 8th ed., Cengage Learning, Andover, available at: https://www.cengage.uk/c/multivariate-data-analysis-8e-hair-babin-anderson-black/9781473756540/?searchIsbn=9781473756540 (accessed 16 April 2026).
12. Vorobiov, V., Cherechin, O., Romaniv, I., Bereza, V., Cherepaniak, V. and Cherepaniak, A. (2023), "Digitalization of the IT Project Management Process", *Academic Visions*, Vol. 26, available at: https://www.academy-vision.org/index.php/av/article/view/1206 (accessed 16 April 2026).
13. Nazarova, G., Jaworska, M., Nazarov, N., Dybach, I. and Demianenko, A. (2019), "Improvement of the Method Measuring the Security of Human Development: Case of Ukraine", *Problems and Perspectives in Management*, Vol. 17, No. 4, pp. 226–238. DOI: https://doi.org/10.21511/ppm.17(4).2019.19
14. United Nations Development Programme (2023), *Human Development Report 2023/2024: Technical Notes*, available at: https://hdr.undp.org/sites/default/files/2023-24_HDR/hdr2023-24_technical_notes.pdf (accessed 16 April 2026).
15. United Nations Development Programme (n.d.), *Human Development Index – Data Center*, available at: https://hdr.undp.org/data-center/human-development-index#/indicies/HDI (accessed 16 April 2026).
16. Eurostat (n.d.), *Eurostat Database*, available at: https://ec.europa.eu/eurostat/data/database (accessed 16 April 2026).

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Відомості про авторів / About the Authors

Назарова Галина Валентинівна – доктор економічних наук, професор, Харківський національний економічний університет імені Семена Кузнеця, завідувач кафедри соціальної економіки, Харків, Україна;
Galyna Nazarova – Doctor of Economic Sciences, Professor, Simon Kuznets Kharkiv National University of Economics, Head of the Social Economics Department, Kharkiv, Ukraine;
e-mail: gnazarova.ua@gmail.com
ORCID ID: https://orcid.org/0000-0003-4893-5406
Scopus Author ID: https://www.scopus.com/authid/detail.uri?authorId=56677560100

Дем'яненко Аліна Анатоліївна – доктор філософії, Харківський національний економічний університет імені Семена Кузнеця, викладач кафедри соціальної економіки, Харків, Україна;
Alina Demianenko – PhD, Simon Kuznets Kharkiv National University of Economics, Lecturer of the Social Economics Department, Kharkiv, Ukraine;
e-mail: alina.demianenko@hneu.net; daa22@ukr.net
ORCID ID: https://orcid.org/0000-0003-0654-698X
Scopus Author ID: https://www.scopus.com/authid/detail.uri?authorId=57212685435

Назаров Нікіта Костянтинович – доктор економічних наук, професор, Харківський національний економічний університет імені Семена Кузнеця, професор кафедри менеджменту, бізнесу і адміністрування, Харків, Україна;
Nikita Nazarov – Doctor of Economic Sciences, Professor, Simon Kuznets Kharkiv National University of Economics, Professor of the Management, Business and Administration Department, Kharkiv, Ukraine;
e-mail: nikita.nazarov@hneu.net
ORCID ID: https://orcid.org/0000-0001-8762-2248
Scopus Author ID: https://www.scopus.com/authid/detail.uri?authorId=56992815100

Іванісов Олег Вікторович – кандидат економічних наук, доцент, Харківський національний економічний університет імені Семена Кузнеця, доцент кафедри соціальної економіки, Харків, Україна;
Oleg Ivanisov – Candidate of Economic Sciences, Associate Professor, Simon Kuznets Kharkiv National University of Economics, Associate Professor of the Social Economics Department, Kharkiv, Ukraine;
e-mail: ivanisovoleg@ukr.net
ORCID ID: https://orcid.org/0000-0001-5757-824X
Scopus Author ID: https://www.scopus.com/authid/detail.uri?authorId=57226544614

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Остапчук Владислав Валерійович – Харківський національний економічний університет імені Семена Кузнеця, здобувач вищої освіти ступеня доктора філософії кафедри соціальної економіки, Харків, Україна;
Vladyslav Ostapchuk – Simon Kuznets Kharkiv National University of Economics, Postgraduate Student of the Social Economics Department, Kharkiv, Ukraine;
e-mail: vladyslav.os106@gmail.com
ORCID ID: https://orcid.org/0009-0001-6122-7765

ДЕТЕРМІНАНТИ РОЗВИТКУ ЛЮДСЬКОГО ПОТЕНЦІАЛУ В УМОВАХ СТРУКТУРНОЇ ТРАНСФОРМАЦІЇ ПРОМИСЛОВОСТІ

Структурна трансформація промисловості в Європі супроводжується глибокими змінами у структурі зайнятості. За цих умов людський розвиток визначає здатність економіки до адаптації, тоді як демографічні та міграційні процеси формують глибинні передумови промислових змін. Метою дослідження є визначення взаємозв'язку між ІЛР та комплексом демографічних та міграційних показників, оскільки їх вплив на ключові виміри ІЛР залишаються актуальним питанням в умовах структурної трансформації промисловості. У статті використовувалися такі методи дослідження: описова статистика; статистичні методи визначення нормальності даних; кореляційний аналіз – для визначення сили та напрямку кореляції; панельне регресійне моделювання дозволило виявити значущі результати в кількісній оцінці впливу факторів. Отримані результати дослідження розкривають статистично значущі зв'язки між демографічними та міграційними показниками та кожним виміром ІЛР. Кореляційний аналіз визначив напрямок, силу та тісноту зв'язків між ключовими змінними. Результати виявили помірний ступінь позитивної кореляції між коефіцієнтом вікової залежності та двома вимірами людського розвитку: Довгим та здоровим життям та Гідним рівнем життя. Аналіз показав сильний негативний вплив коефіцієнта смертності майже на всі виміри ІЛР. Чистий коефіцієнт міграції має значний позитивний вплив на два виміри людського розвитку: Знання та Гідний рівень життя, а також на ІЛР в цілому. Чистий коефіцієнт міграції та загальний коефіцієнт імміграції стали предметом аналітичного інтересу для майбутніх досліджень як компенсуючі фактори, збільшення яких може пришвидшити прогрес ІЛР. Результати кореляційного аналізу дозволили виявити вплив інших показників на виміри ІЛР, але такий вплив був слабким, нелінійним або контекстно-залежним. Регресійний аналіз, проведений для кожного виміру людського розвитку, дав змогу зробити висновки, що мають високу практичну цінність. Побудовані моделі створили емпіричну основу для визначення ключових факторів впливу та дозволили проводити прогнозування, а також розробляти стратегії спрямовані на зміцнення стійкості людського капіталу та розвитку людського потенціалу в умовах структурної трансформації промисловості.

Ключові слова: розвиток людського потенціалу; індекс розвитку людського потенціалу; людський капітал; демографічна динаміка; міграційні ризики; структурна трансформація; промисловість.

Бібліографічні описи / Bibliographic descriptions

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