

**Publisher**<http://jssidoi.org/esc/home>**THE TRANSFORMATION OF THE COUNTRY'S HIGHER EDUCATION SYSTEM UNDER THE INFLUENCE OF MIGRATION PROCESSES*****Olena Rayevnyeva¹, Volodymyr Ponomarenko², Silvia Matusova³, Olha Brovko⁴, Lubica Filipová⁵**^{1,3,5} Bratislava University of Economics and Management, Department of Economics and Finance, Furdekova 16, 85104 Bratislava, Slovakia^{2,4} Simon Kuznets Kharkiv National University of Economics, av. Nauki 9-a, 61166 Kharkiv, UkraineE-mails: ¹olena.raev@gmail.com (Corresponding author); ²post@hneu.edu.ua; ³silvia.matusova@vsemba.sk; ⁴ol.iv.brovko@gmail.com; ⁵lubica.filipova@vsemba.sk

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Abstract. A high level of instability in world processes characterises the 21st century. This is caused by innovations in scientific and technological progress and the negative consequences of political and economic crises. New challenges have arisen for the higher education system, which determines the need to transform a traditional university into an entrepreneurial structure that must adapt to changes in the external environment. Migration processes significantly influence countries' higher education systems (HES), and their analysis and modelling aim to create competitive advantages for HES and universities. The article is devoted to analysing and forecasting trends in the development of universities in Ukraine and Slovakia, depending on the preferences of general and educational migration. Research methods include systematic and conceptual approaches, monographic analysis, index and cluster analysis, econometric modelling, taxonomy method, and statistical data analysis. It is substantiated that migration processes have a steady upward trend, and the progressive growth of migration of Ukrainians to Europe is provoked by Russian aggression against Ukraine. It has been determined that the search for countries with a high quality of life and education causes the migration preferences of the population. An analysis of the attractiveness of HES in Ukraine and Slovakia was carried out, and the strengths and weaknesses were identified. Models of the level of attractiveness of HES in Ukraine and Slovakia have been constructed, and promising directions for their development have been identified.

Keywords: higher education system; migration; HDI; GKI; educational migration trends; conceptual model; cluster analysis; integral indicator; adaptive short-term forecasting method

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1. Introduction

The current stage of development of the world's higher education system (HES) is characterised by significant challenges provoked by political and economic instability in various regions of the world and technological changes of the 21st century. Global shocks such as COVID-19 and military conflicts in Asia and Europe (for example, the Russian and Ukrainian conflict) have created a new round of economic instability in countries

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worldwide, powerful migration flows that pose new challenges to higher education. The HES of countries that are at the focus of such conflicts, in particular Ukraine, are faced with both financial problems caused by the deteriorating state of the economy and the problems of a significant outflow of applicants, students, and teachers caused by a sharp decline in the quality of life and the general situation threats to life. Against this background, universities must not only localise the consequences of crisis phenomena but also maintain the ability to adapt to modern information and communication innovations to support the quality of the educational process.

Migration is and will remain one of the globalising problems of the world in the 21st century. Openness to the world, on the one hand, provided the citizens of the countries with new opportunities. Still, on the other hand, it created new risks, primarily associated with mass emigration of the population abroad. Today, European countries are criticised for the lack of a coherent and coordinated policy in the face of the refugee crisis and for insufficiently thought-out response mechanisms, which seriously limits timely decisions and effective implementation of migration policy. As a result, the volume of international migration is rapidly increasing and significantly impacting the sphere of economy, education, and social processes. In the economic sphere, migration can contribute to the expansion of the scale of the shadow economy, worsening the situation in the labour market and displacing workers from among residents.

The emergence of educational migration is a manifestation of migration movements in the educational environment. The deepening of the internationalisation of economic relations and the development of integration processes led to the expansion of opportunities for study and academic exchanges abroad and the demand for high-quality international education services. The growing role of intellectual capital in developing national economies actualises studying the causes, consequences and prospects of international educational migrations and academic mobility. Since most migrants are young people, that is, the most active part of the population, prone to self-development and adaptation in a multicultural environment, their loss has extremely negative socio and economic consequences for any economy. In addition, the globalisation of the world educational market has caused a new round of competition between universities for "young minds". High-quality higher education in the conditions of a significant increase in the demand for a knowledge-intensive workforce, on the one hand, becomes a critical competitive advantage of the state and, on the other hand, creates a competitive advantage of the attractiveness of a particular university for applicants. Therefore, analysing the impact of migration processes on the further development of the country's HES is an urgent scientific research problem.

2. Literature review

The problems of transforming the HES are the focus of research by modern scientists. The emergence of the phenomena of the "knowledge society" and the "knowledge economy", the global trend of digitalisation of society and the economy, the rapid diffusion of information and technological innovations into all spheres of life of civilisation, the growing demand of the labour market for a knowledge-intensive workforce - these are a few of the challenges that require a radical transformation of countries' higher education systems and adaptation of the activities of universities to them. In these new conditions, universities must perform their historical function in a new way - to be a source of new knowledge and its transfer to future generations.

A characteristic feature of the transformation of the global higher education system in recent decades is the transformation of a traditional university into an innovative and active entrepreneurial organisation open to technological changes and the digitalisation of society's socio and economic processes.

Universities around the world are facing the challenges of digital transformation. They must adapt to them while maintaining and improving the quality of educational services for students, employees, and key stakeholders. This requires the development of a strategy for digital transformation both at the state level and at the level of a separate higher education institution, the formation of new information and communication skills among students and teachers, and the digital maturity of society as an environment in which the university operates. According to many scientists (Berman and Bell, 2011; Shelepaeva, 2023; Bucata, Popescu, Tileaga, 2022; Toktarova, Rebko, Semenova, 2023), the success of such a transformation and overcoming challenges depends on the readiness of universities for changes, the availability of resources to improve the quality of educational

services and the expansion of partnership relations between HES and stakeholders. Today, more than ever, countries face the problem of forming a state migration policy capable of minimising risks and, at the same time, promoting the use of the positive effect of migration. Doing so in the face of resource scarcity and economic instability is extremely difficult but vital for every country. The issue of migration, the legal aspects of regulating migration processes, and the development of an effective migration policy have been studied at various times by both domestic and foreign scientists, namely Górny, Kaczmarczyk (2019), Vollmer (2017), Buckler, Swatt, Salinas (2009), Malynovska (2022), Libanova (2018), Libanova, Pozniak, Tsymbal (2022), Simakhova, Tserkovnyi (2022) and others. In particular, Hobolt (2018) notes in his research that migration began to be actively discussed at the national level in connection with the so-called "refugee crisis" and the Brexit referendum. Karolewski and Benedikter (2017) emphasise that public debates on migration issues are becoming increasingly important and determine the solution to new migration policy issues. The problems of external labour migration in different periods were studied in detail in the works of such scientists as Theoharides (2020), Coulombe, Trembley (2006), Haan, Jin, Paul (2023) and others. However, analytical studies of migration processes since the start of the COVID-19 pandemic are fragmentary. Problems and challenges of educational mobility and educational migration are presented in the works of Arif (2022), Hatton (2014), Cichorzewska (2022), Zatonatska et al. (2022). The authors consider educational migration as a tool for implementing strategic human capital management and the degree of influence of international educational migration on territorial economic systems. In addition, today, the market for educational services is characterised by fierce competition for applicants, which, of course, activates educational migration, especially the departure of young people abroad to study. A large number of scientists, namely Suleiman (2023), Ozturgut (2011), Balalaieva et al. (2023), believe that one of the problems of educational migration is the low level of quality of education in the country. That is why all aspects of the impact of educational migration processes on the country receiving migrants and on the donor country in terms of both the national economy and individual regions of the world require in-depth research.

3. Research objective and methodology

The study is devoted to analysing and forecasting trends in the development of the HES in Ukraine and Slovakia, depending on the preferences of general and educational migration.

To achieve the goal of the study, the following tasks are solved:

1. Study of the characteristic features and trends of migration processes in the world, identifying the dominant causes of migration;
2. Classification of countries of the world according to the level of quality of life and quality of education using the human development index (HDI) and the global knowledge index (GKI);
3. Determination of trends in educational migration in Slovakia and Ukraine;
4. Analysis of trends in the development of the HES in Ukraine and Slovakia;
5. Modeling changes in HES of Ukraine and Slovakia, analysis of results.

The solution to the tasks is based on the proof of the following hypotheses:

1. The transformation of countries' HES should correlate with trends in the development of civilisation, global processes of digitalisation of the economy and society, and current and future demands of the labour market.
2. Increased political and economic instability in the world is provoked by increased migration processes, including educational migration processes, which, in turn, require the modernisation of HES in each country.
3. Global and national processes of educational migration are sensitive to the quality of life and the quality of the country's HES, which determines the migration preferences of the population.
4. The countries' governments should determine the readiness of the countries' HES for the transformations of the 21st century to create a favourable legislative and regulatory environment for such changes and the readiness of universities to introduce information and communication innovations into their processes.
5. Tools for monitoring and modelling development trends in the country's HES need constant improvement, depending on the specific trends in changes in the world's HES.

Research methods include system and conceptual approaches, monographic and comparative analysis, analysis and synthesis, index and cluster analysis, econometric modelling, taxonomy method, statistical data analysis, and visualisation tools. The conceptual model of the study is shown in Figure 1. To solve the above problems,

the study used international indices, namely the HDI and the GKI, education statistics from the UNESCO Institute for Statistics and the World Bank, Eurostat statistics for the period 2000-2022, migration statistics from UNHCR (UN Agency for refugees) for the period 1992-2022. To classify countries by quality of life, the study used the *Human Development Index (HDI)*. The HDI is a comprehensive measure of a country's level of human development and is, therefore, sometimes used synonymously with concepts such as "quality of life" or "standard of living". It was developed in 1990 and published by the United Nations Development Program in the Human Development Reports.

Contents of the model stages

Model and statistical research tools

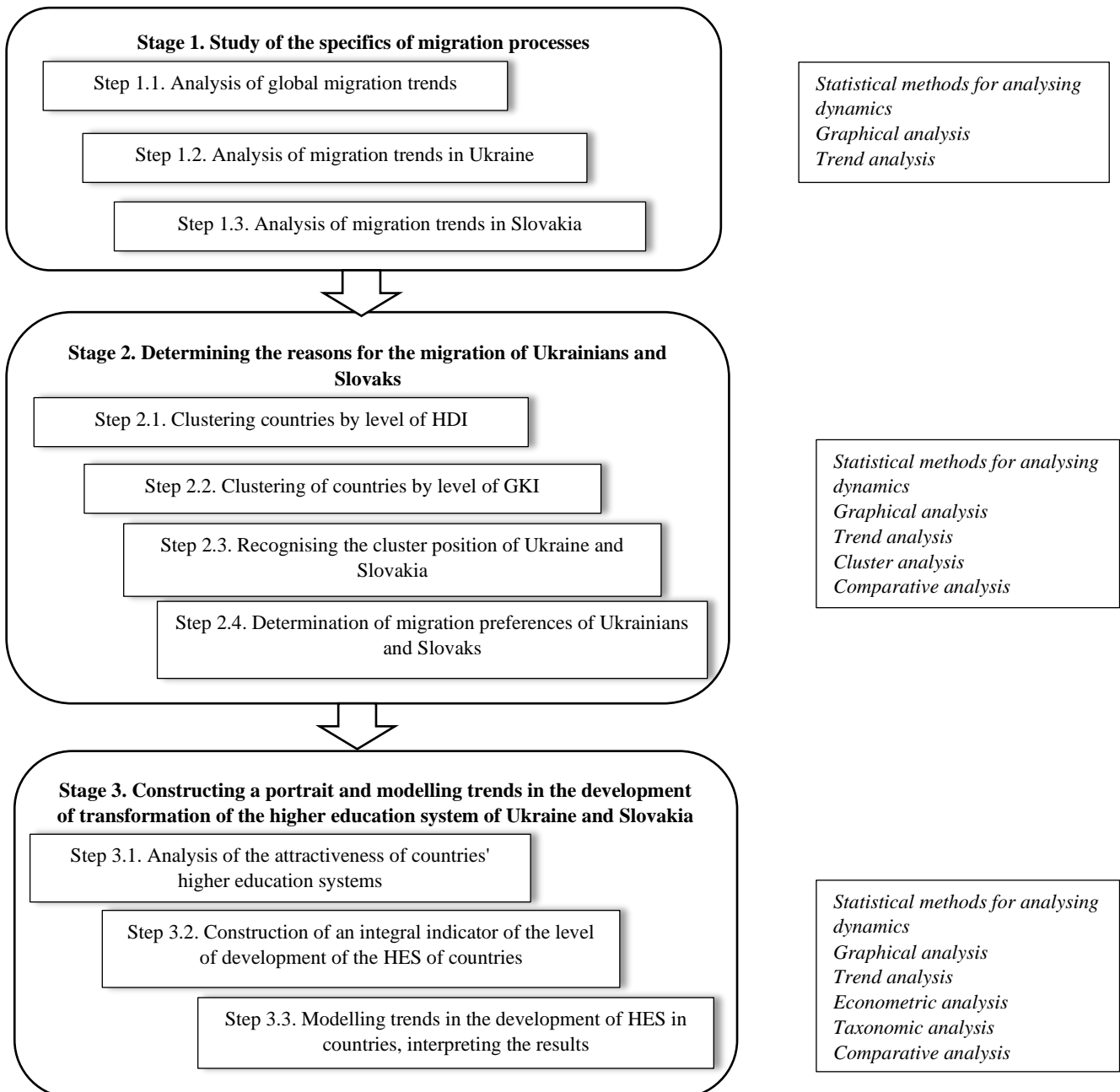


Figure 1. Conceptual research model

Source: compiled by the authors

The index measures the country's achievements in the field of healthcare, education, real income of its citizens and when calculating, it takes into account indicators in the following areas:

- Long and Healthy life, measured by life expectancy at birth.
- Knowledge, measured by adult literacy rate and gross enrollment ratio.
- A decent standard of living, measured by gross domestic product (GDP) per capita in US dollars at purchasing power parity (PPP).

The formation of this index is evolutionary. Thus, until 2013, the HDI was called the "Human Development Potential Index". The following indices are currently calculated (Human Development Report 2021/2022):

- *Human Development Index (HDI)*.

$$HDI = \langle \text{Life expectancy index, Education index, GNI index} \rangle$$

- *Inequality-adjusted Human Development Index (HDII)*.

$$HDII = \langle \text{Inequality-adjusted life expectancy index, Inequality-adjusted education index, Inequality-adjusted income index} \rangle$$

- *Gender Development Index (GDI)* contains these indicators for women and men.

$$GDI = \langle \text{Human Development Index (female), Human Development Index (male)} \rangle$$

- *Gender Development Index (GII)*.

$$GII = \langle \text{Female gender index, Male gender index} \rangle$$

- *Multidimensional Poverty Index (MPI)*.

$$MPI = \langle \text{Intensity of poverty, Headcount ratio} \rangle$$

To calculate a country's HDI, the formula for the geometric average of the three indicated indicators is used. HDI values range from 0 to 1, making it possible to rank countries according to the quality of the population's life.

The *Global Knowledge Index (GKI)* is used to measure the performance of a country's education system. It was created in 2017 and is calculated for 132 countries. The index allows you to systematically monitor the impact of knowledge on the socio and economic development of the country.

In 2022, this index was modified. Table 1 shows the structure of the index and changes in its components.

Table 1 shows that changes in the structure of the index occurred in the composition of its pillars, which is aimed at increasing the degree of accessibility of information while maintaining the maximum number of countries in the survey. The total number of indicators by which the index is calculated is 155.

They are monitored based on data from 40 international databases, such as the United Nations Educational, Scientific and Cultural Organization (UNESCO); the World Bank; the International Telecommunication Union (ITU); the World Economic Forum (WEF); the International Monetary Fund (IMF); the Organisation for Economic Co-operation and Development (OECD); the International Labour Organization (ILO) and other United Nations agencies and international organisations.

All this makes it possible to use this index in studies of the effectiveness and impact of knowledge on the country's development.

Table 1. Global knowledge index structure

Sectoral indices/ Sub- indices	2017	2022
	Old pillars	New pillars
Pre-university education	knowledge capital	knowledge capital
	educational enabling environment	educational enabling environment
Technical and vocational education and training (TVET)	formation and professional training	TVET components
	features of the labour market	TVET labour market
Higher education	inputs	inputs
	outputs	learning environment
Research, development and innovation (RDI)	research and development	inputs
	innovation in production	outputs
	Societal innovation	impact
Information and communications technology (ICT)	ICT inputs	infrastructure
	ICT outputs	access
		usage
Economy	knowledge competitiveness	economic competitiveness
	economic openness	economic openness
	financing and value-added	financing and domestic value-added
Enabling environment	political and institutional	governance
	socio-economic	socio-economic
	health and environment	health and environment

Source: Human Development. Report 2021/2022 (UNDP, Human Development Report)

The general structure of the index can be represented by the following tuple:

$$GKI = \langle \text{Sectoral indices}; \text{Pillars}; \text{Sub-pillars}; \text{Variables} \rangle$$

The weight of each sector index is 15%, and the weight of the Enabling Environment sub-index is 10%. The formula for calculating GKI is as follows:

$$CI = \sum_{j=1}^n w_j * SC_j$$

where CI - proposed composite indicator to be computed (sub-index, pillar or sub-pillar); w_j - the relative weight of the sub-component SC (pillar, sub-pillar, or variable); n - the number of sub-components aggregated to form the composite indicator. To determine the direction of development of the HES in the country, the study uses the "Higher Education" sub-index. In fact, the HES is a key element of economic knowledge. It forms the knowledge and skills necessary for the modern and, most importantly, future development of civilisation, the labour market and society's needs. The tuple structure of the sub-index (I_{HE}) and its component is as follows:

$$I_{HE} = \langle \text{Input (Expenditure, Enrolment, Resources); Learning environment (Diversity and academic freedom, Equity and inclusiveness); Output (Attainment, Employment, Impact)} \rangle$$

The total number of indicators that assess the level of development of higher education in the country and its impact on the development of society is 19 indicators. The information base of the GKI study is made up of reporting data "The Global Knowledge Index" 2020-2022, which was developed by the United Nations Development Programme (UNDP) Regional Bureau for Arab States (RBAS), One United Nations Plaza, NEW YORK, NY10017, USA and Mohammed Bin Rashid Al Maktoum Knowledge Foundation (MBRF) [The Global Knowledge Index 2020-2022].

To identify groups of countries that are homogeneous in terms of GKI level, the study used *cluster analysis*, namely *the k-means method*. This made it possible to identify stable groups of countries according to the quality of education and its impact on the development of society. The k-means method belongs to the group of iterative

methods of non-hierarchical clustering. Non-hierarchical clustering consists of iteratively dividing a set of initial data into a certain number of individual clusters, which the researcher specifies. The advantages of this method are simplicity and speed of use, clarity and transparency of the algorithm. The clustering quality is checked using the following functionals (Table 2).

Table 2. Clustering quality functionals

Functional name	Calculation formula
The sum of squared distances to the center of the cluster	$F_1 = \sum_{l=1}^k \sum_i d^2(X_i, \bar{X}_l), \quad F_1 \rightarrow \min$
The sum of internal cluster distances between objects	$F_2 = \sum_{i=1}^k \sum_j d_{ij}^2, \quad F_2 \rightarrow \min$
Total within-cluster variance	$F_3 = \sum_{l=1}^k \sum_j \sigma_{ij}^2, \quad F_3 \rightarrow \min$

To analyse and model trends in the development of the HES of Ukraine and the Slovaks, the study has used the *taxonomic method of the development level* (Pluta, 1989). This method was developed by Polish scientists and allows one to assess the level of development of the analysed object in n-dimensional space of indicators. The tool of this method is an integral indicator that reflects the synergistic effect of the influence of various indicators of an object's behaviour from a systemic point of view. The integral indicator varies within the range [0 ÷ 1] and is interpreted as follows: the higher the indicator value is reduced to 1, the higher the level of development of the object.

The formula for calculating the integral indicator (D_i) is as follows:

$$D_i = 1 - \frac{C_{i0}}{C_0}$$

where $C_0 = \bar{C}_0 + 2 * S_0$, $\bar{C}_0 = \frac{\sum_{i=1}^w C_{i0}}{w}$, $S_0 = \sqrt{\frac{\sum_{i=1}^w (C_{i0} - \bar{C}_0)^2}{w}}$, $i = [l \div w]$ – number of objects

4. Results and recommendations

Stage 1. Study of the specifics of migration processes

In the conditions of the spread of dynamic globalisation processes, migration is a natural phenomenon and the main feature of the development of all world countries, which threatens the sustainable development of the country's national economy (hypothesis 2). Migration movements are the population's response to changes occurring in any society's political, social and economic life. The appearance, spread and volume of such phenomena indicate the stability or, on the contrary, the instability of political and economic development in the state. To confirm/refute this hypothesis, the study analysed general migration processes in the world and Ukraine and Slovakia from 1992-2022. The source of statistical information is the World Data Atlas and UNHCR.

Step 1.1. Analysis of the number of international migrants in the world made it possible to distinguish two periods (Fig. 2):

The 1st period - 1992 - 2005 is characterised by a tendency to decrease the number of migrants. During this period, the number of migrants decreased by 45%;

The 2nd period - 2006 - 2022 is characterised by a rapid increase in the number of migrants. So, as of the end of 2019, the total number of international migrants was 272 million people (3.5% of the world population), and the largest group among them was labour migrants. In 2013 - 2017, their share in the overall structure of world migration flows was 40%. Thus, during this period, the total number of migrants worldwide increased by a record 35% (8.9 million people), and in 2022 it reached 34.8 million.

In recent years, Europe, including Turkey, has received more than a third (36%) of the world's migrants. Turkey remains the country that received the largest number of migrants. Thus, as of the end of 2022, it was home to

3.6 million refugees, which is more than 10% of all international migrants. Germany is the second country that received almost 2.1 million people, that is, 6% of refugees in the world. The number of migrants in European countries increased to 12.4 million in 2022, compared to 7 million in 2021. This rapid increase was mainly due to the fact that refugees from Ukraine were fleeing the international armed conflict in the country.

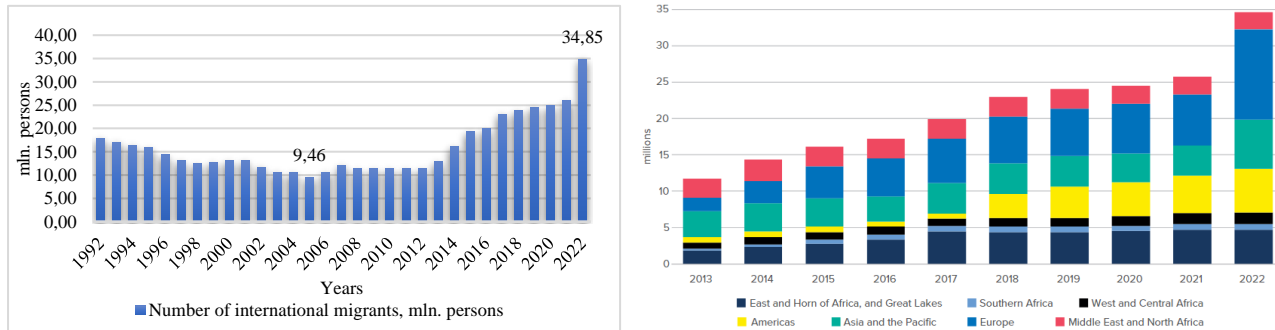


Figure 2. The general trend of international migrants for 1992-2022, million people
 Source: compiled by authors based on World Data Atlas and UNHCR

Analysis of the nationality of migrants allowed us to conclude that more than 87% of all international migrants by the end of 2022 came from only 10 countries. Almost 1 in 5 international migrants were Syrians, totalling 6.5 million people. Over 77% of Syrians lived in neighbouring countries, including Turkey (3.5 million), Lebanon (814.700) and Jordan (660.900). However, at the end of 2022, Ukrainians became one of the main migrants in the world, the number of which amounted to 16% of refugees in the world.

Step 1.2. Migration processes are not a new phenomenon for Ukraine itself. The migration of Ukrainians abroad, especially to Europe, continued throughout the period after 1991. It was mainly labour migration and, as a variant of it, pendulum migration, in which Ukrainians worked either seasonally or part-time; some labour migrants also worked for a long time and worked abroad without returning to the country. The accelerated growth of emigration of citizens causes many negative consequences, the main ones of which are a decrease in the economic growth rate of Ukraine, acceleration of the "ageing of the nation", and slowing down of population reproduction processes. These consequences pose a threat to the economic security of Ukraine in the long term. From 2000 to 2017, 6.3 million people left Ukraine and did not return (3.1 million left through the western border and 3.2 million through the eastern border). In the 2017 Migration Report of the UN Special Commission, it is stated that 5.9 million people have left the territory of Ukraine and are currently in the status of labour migrants in other countries of the world (Fig. 3) (World Data Atlas and UNHCR).

Ukrainian refugees increased from 27.3 thousand in 2021 to 5.7 million in 2022. It was the fastest outflow of refugees since World War II, triggered by the outbreak of full-scale war in Ukraine following the Russian invasion in February 2022. Almost 2.6 million refugees from Ukraine were resettled in neighbouring countries and another 3 million in other European countries and beyond (Fig. 4).



Figure 3. The trend of international migrants from Ukraine for 1992-2022
 Source: compiled by authors

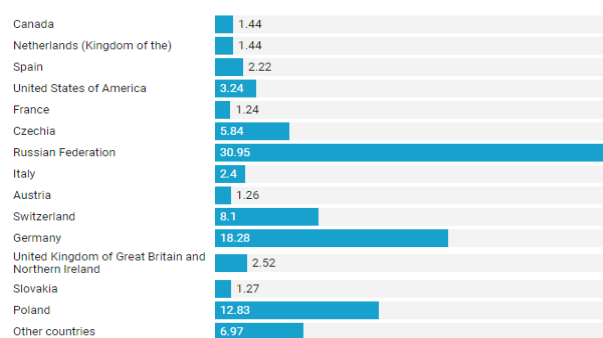


Figure 4. The percentage of migrants from the total number of people who left Ukraine for the period 1994 - 2022
 Source: compiled by authors

Thus, between 1994 and 2022, 7.49 million people left Ukraine. The analysis made it possible to identify 5 countries to which the largest number of Ukrainians left: the Russian Federation - 2.32 million people (30.95%), Germany - 1.34 million people (18.28%), Poland - 0.96 million people (12.83%), the Czech Republic - 0.44 million people (5.84%) and the USA - 0.24 million people (3.24%).

Step 1.3. Slovakia is considered one of the most economically successful countries in the Central and Eastern region of Europe. Economic reforms and accession to the EU, combined with a significant inflow of foreign direct investment, led to sustained economic growth and new jobs, contributing to a decrease in the number of emigrants (Fig. 5).

For the period 1994-2022, four stages can be distinguished in the migration flows of Slovakia:

- 1) periods of increased migration from 1992 to 2002 and from 2014 to 2021;
- 2) periods of decline in migration from 2002 to 2007 and from 2021 to the present.

However, the country has developed a trend of increasing migration, which reflects the outflow of skilled labor abroad. Considering that the aging index of Slovakia is one of the most dynamic in Europe, migration processes pose a threat to the economic development of the country.

For Slovaks, the higher income level in the EU countries compared to Slovakia is a sufficient motivation for emigration. For example, in 2004, Slovakia joined the EU, which improved the country's economic situation and reduced migration flows.

During the period 1994-2022, 14,500 people left Slovakia. Among the migrants is an educated and young workforce. This is the main reason for implementing state measures to reduce the outflow of skilled labour abroad (Fig. 6).

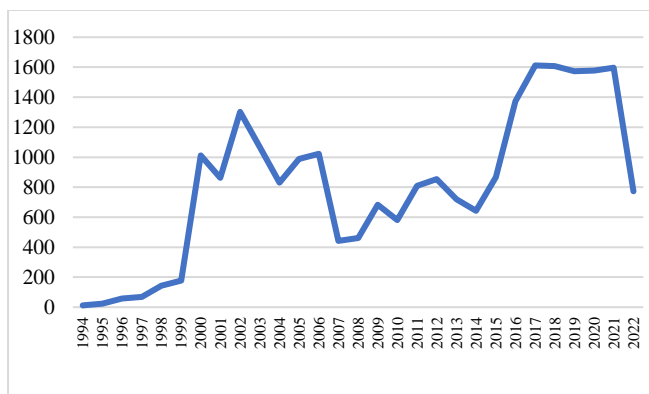


Figure 5. The trend of international migrants from Slovakia for 1994 – 2022
 Source: compiled by authors

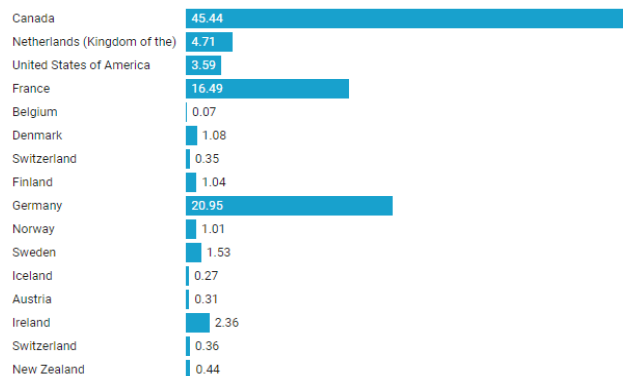


Figure 6. The percentage of migrants from the total number of people who left Slovakia for the period 1994 - 2022
 Source: compiled by authors

Almost half of those migrating from Slovakia went to Canada - 36.6 thousand people, which is 45.44% of the total number of migrants. In addition to Canada, the following countries are popular among Slovaks: Germany - 20.95% (3.05 thousand people), France - 2.4 thousand people (16.49%), the Netherlands - 686 people (4.71%) and the USA – 522 people (3.59%).

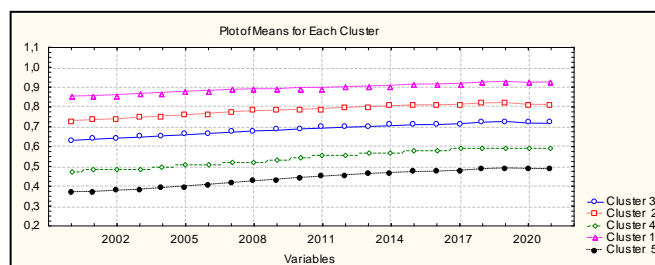
Comparing migration trends in Ukraine and Slovakia, the following can be noted. Political crises have a significant impact on the volume of migrants from Ukraine. Thus, the surge in the number of migrants in 2014-2015 is due to the situation with the Crimea, Donetsk and Luhansk regions. After 2016, Ukrainians gradually returned home. The trend of migration flows for Slovakia is constantly increasing, which indicates a constant outflow of population to countries with a high quality of life.

Stage 2. Determining the reasons for the migration of Ukrainians and Slovaks.

One of the research hypotheses (hypothesis 3) is that the population migrates to countries with higher standards of living and education since education significantly impacts a high standard of living in the future. To prove/refute this hypothesis, two international indices were selected in the study - the HDI and the GKI.

Step 2.1. In the study, HDI values were analysed for the period 2001-2021, which made it possible to identify stable groups of countries according to the quality of the population's life. The characteristics of cluster groups and the quality of their division are shown in Fig. 7.

Cluster number	Cluster name	Cluster means
1	the highest level	0.84 – 0.92
2	high level	0.72 – 0.81
3	medium level	0.63 – 0.72
4	low level	0.48 – 0.59
5	the lowest level	0.36 – 0.48



a) Characteristics of cluster groups

b) Cluster mean plot

Figure 7. Characteristics and quality of cluster partitioning

Source: compiled by authors

Fig. 1 shows that 5 clusters were obtained, which have a high quality of partitioning because graphs of average values for the entire analysed period do not intersect. The results of grouping countries into clusters are presented in Table. 3.

Step 2.3. Table 3 shows that Ukraine and Slovakia have been classified as countries with a high standard of living for 10 years.

Despite belonging to the same cluster, the positions of Ukraine and Slovakia have specific differences. Slovakia's average annual HDI growth for 1990-2021 was 0.66%; a similar figure for Ukraine is 0.19% (Human Development Index)

Table 3. Grouping of countries into clusters: HDI

Cluster number	List of countries
1 cluster - the highest level	Japan, Korea, Andorra, Switzerland, France, Luxembourg, Malta, Italy, Spain, Netherlands, Poland, Belgium, Sweden, Czechia, Denmark, Austria, Greece, Estonia, Ireland, Lithuania, Norway, Iceland, Finland, United Kingdom, Slovenia, Liechtenstein, Germany, Canada, United States, Australia, New Zealand, Hong Kong, China, Singapore, Cyprus, Qatar, Qatar, Israel
2 cluster - high level	Libya, Mauritius, Seychelles, Kazakhstan, Armenia, Sri Lanka, Georgia, Barbados, Cuba, Costa Rica, Panama, Trinidad and Tobago, Bahamas, Belarus, Bulgaria, Hungary, Portugal, Romania, Slovakia , Latvia, Russian Federation, Croatia, Ukraine , North Macedonia, Albania, Bosnia and Herzegovina, Serbia, Mexico, Palau, Malaysia, Brunei Darussalam, Venezuela, Argentina, Chile, Uruguay, Bahrain, Kuwait, Oman, Iran, Saudi Arabia, Turkey
3 cluster - medium level	Algeria, South Africa, Egypt, Gabon, Cabo Verde, Tunisia, Botswana, Morocco, Mongolia, Tajikistan, Kyrgyzstan, Uzbekistan, Azerbaijan, Maldives, China, Dominica, Saint Lucia, Saint Lucia, Dominican Republic, Jamaica, Nicaragua, Belize, El Salvador, Moldova, Tonga, Samoa, Fiji, Philippines, Thailand, Viet Nam, Indonesia, Brazil, Colombia, Peru, Ecuador, Paraguay, Bolivia, Guyana, Iraq, Syrian Arab Republic, Jordan
4 cluster - low level	Congo, Ghana, Angola, Kenya, Comoros, Cameroon, Benin, Eswatini, Equatorial Guinea, Zimbabwe, Zambia, Madagascar, Sao Tome and Principe, Mauritania, Namibia, Pakistan, Bangladesh, India, Nepal, Guatemala, Honduras, Micronesia, Kiribati, Papua New Guinea, Solomon Islands, Lao People's Democratic Republic, Myanmar, Cambodia
5 cluster - the lowest level	Rwanda, Guinea, Lesotho, Central African Republic, Burkina Faso, Togo, Sierra Leone, Liberia, Djibouti, Gambia, Cote d'Ivoire, Ethiopia, Burundi, Mali, Chad, Sudan, Malawi, Mozambique, Niger, Tanzania, Senegal, Uganda, Afghanistan, Haiti, Yemen

Source: compiled by authors

Table 4. Values of HDI for Slovakia and Ukraine (2021)

Object	Index	HDI	Inequality-adjusted HDI	GDI	GII
Slovakia		0.850	0.803	0.999	0.180
Ukraine		0.773	0.726	1.012	0.200
World		0.732	0.590	0.958	0.465

Source: Human Development Report 2021/2022

Development Report 2021/2022]. As of 2021, Slovakia's rating is 0.85, and Ukraine has a rating of 0.77. Table 4 presents the values of the human development index and its modifications for two countries. Tables 5-7 show the values of the components of these indices for Ukraine and Slovakia.

Table 5. Inequality-adjusted HDI

Object	Index	Coefficient of human inequality	Inequality in life expectancy	Inequality-adjusted life expectancy index	Inequality in education	Inequality in income	Inequality-adjusted income index	Gini coefficient
Slovakia		5.2	4.7	0.805	1.7	0.819	9.1	23.2
Ukraine		6.0	5.8	0.748	3.6	0.758	8.5	25.6
World		19.4	13.2	0.686	21.7	0.503	23.2	

Source: Human Development Report 2021/2022

Table 6. Gender Development Index

Object	Index	HDI (F/M)	Life expectancy at birth(F/M)	Expected years of schooling(F/M)	Mean years of schooling(F/M)	Mean years of schooling(F/M)
Slovakia		0.847/0.848	78.4/71.5	15.0/14.0	12.9/13.0	24.9/36.8
Ukraine		0.776/0.766	76.7/66.5	15/14.9	11.5/10.7	10.37/16.61
World		0.715/0.747	74/68.9	12.9/12.7	8.4/8.9	12.241/21.21

Source: Human Development Report 2021/2022

Table 7. Gender Inequality Index

Object	Index	Maternal mortality ratio	Adolescent birth rate	Share of seats in parliament	Population with at least some secondary education (F/M)	Labour force participation rate (F/M)
Slovakia		5	26.3	22.7	98.9/99.2	47.8/62.0
Ukraine		19	15.6	20.8	96.2/95.8	48.1/63.6
World		225	42.5	25.9	64.2/70.3	46.2/71.7

Source: Human Development Report 2021/2022

Data analysis tables 4-7 allowed us to draw the following conclusions:

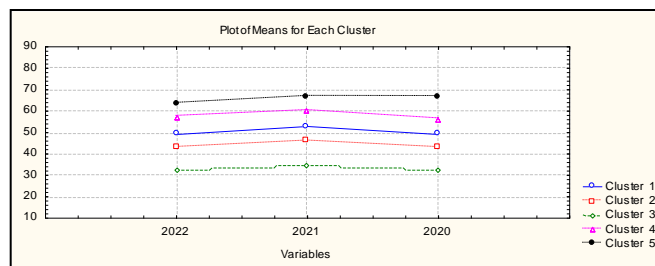
1. Slovakia and Ukraine have HDI values above the world average, which indicates their position in the cluster of countries with a high level of human development.
2. Both countries have Inequality-adjusted HDI values above the world average. This is a negative trend. The data in Table 5 shows that countries have problems with only 2 components of the index: Inequality-adjusted life expectancy index and inequality in income. Therefore, governments must create conditions that will reduce inequality in income and life expectancy.
3. The HDI values for Ukraine and Slovakia practically coincide and correspond to the level of the world average, which indicates the existence of equal opportunities for the development of men and women in the

countries (Table 6). A slight decrease from the world average level is observed in Ukraine for the Mean years of schooling (F/M) component, but this does not affect the country’s high position in this direction.

4. The values of the Gender Inequality Index components diagnose the absence of inequality in human development for men and women (Table 7). In Ukraine and Slovakia, the state pays close attention to the observance of rights for different gender groups, which creates a society of equal opportunities.

Step 2.2. To identify homogeneous groups of countries according to the level of quality of education and its impact on the development of society, the study used the GKI. The characteristics of cluster groups and the quality of their division are shown in Fig. 8.

Cluster number	Cluster name	Cluster means
1	the highest level	63 - 67
2	high level	57-61
3	medium level	49-53
4	low level	42-46
5	the lowest level	32-35



a) Characteristics of cluster groups

b) Cluster mean plot

Figure 8. Characteristics and quality of cluster partitioning
Source: compiled by authors

Considering that the graphs of average values for cluster groups do not intersect, we conclude that the grouping of countries is of high quality. Table 8 shows the results of classifying countries for the analysed period.

Table 8. Grouping countries into clusters: GKI

Cluster number	List of countries
1 cluster - the highest level	Sweden, Finland, Denmark, Netherlands, Norway, New Zealand, Germany, Australia, Switzerland, Ireland, United States, United Kingdom, Belgium, Iceland, Austria, Hong Kong, China, Estonia, Luxembourg, Japan, Singapore, France, Israel, Korea, Rep, United Arab Emirates
2 cluster - high level	Canada, Spain, Czech Republic, Hungary, Slovenia, Italy, Malta, Lithuania, Slovakia , Portugal, Cyprus, Poland, Latvia, Croatia, Qatar, China
3 cluster - medium level	Greece, Chile, Barbados, Bahrain, Romania, Bulgaria, Uruguay, Trinidad and Tobago, Russian Federation, Ukraine , Belarus, Mauritius, Kuwait, Thailand, Georgia, Moldova, Oman, Malaysia, Serbia, Saudi Arabia, Costa Rica
4 cluster - low level	Brazil, Argentina, Panama, South Africa, Turkey, Bosnia and Herzegovina, Armenia, Mexico, Kazakhstan, Peru, Jordan, Colombia, Guyana, Tunisia, Azerbaijan, Lebanon, Albania, Mongolia, Botswana, El Salvador, Dominican Republic, Paraguay, Philippines, Iran, Islamic Rep, Kyrgyz Rep, Algeria, Egypt, Arab Rep, Ecuador, Bolivia, Sri Lanka, Morocco, Cabo Verde, Vietnam, Uzbekistan, Indonesia, Honduras, India, Kenya, Ghana, Rwanda, Cambodia
5 cluster - the lowest level	Venezuela, RB, Guatemala, Tajikistan, Senegal, Pakistan, Uganda, Zimbabwe, Lesotho, Malawi, Burkina Faso, Benin, Mali, Tanzania, Madagascar, Mozambique, Lao PDR, Cameroon, Mauritania, Nepal, Cote d'Ivoire, Bangladesh, Ethiopia, Guinea, Angola, Myanmar

Source: compiled by authors

Step 2.3. Table 8 shows that Slovakia ranks higher than Ukraine. Thus, Slovakia belongs to cluster 2 – countries with a high level of knowledge development, and Ukraine is in cluster 3, which is typical for countries with an average level of knowledge development. Analysis of these GKI values for Slovakia and Ukraine over three years shows a stable position for each country. To determine the reasons for this condition, a comparative analysis of the index values with the world average and the highest values was carried out.

Table 9 reflects a comparative description of each GKI sub-indices and the world average value for 2022.

Table 9. GKI sub-indices values: Ukraine, Slovakia, world and highest level (2022)

Sub- indices	Level of Ukraine	Level of Slovakia	Mean level of world	The highest level
Pre-university education	79.82	78.17	62.73	85.54 (Belarus)
Technical and vocational education and training (TVET)	49.9	68.99	51.88	70.05 (UAE)
Higher education	43.47	56.87	45.7	66.83 (Switzerland)
Research, development and innovation (RDI)	23.94	27.17	26.46	54.32 (Switzerland)
Information and communications technology (ICT)	48.92	53.55	44.83	73.09 (Singapore)
Economy	44.82	58.43	52.91	81.6 (Singapore)
Enabling environment	54.4	70.18	57.52	88.65 (Norway)

Source: The Global Knowledge Index, 2022

A detailed study of the GKI sub-indices for Slovakia and Ukraine as of 2022 allows us to draw the following conclusions:

1. The overall value of the GCI of Ukraine (46.95) is almost equal to the average state of the GKI in the world (46.47). This means that Ukraine ranks on average, 63rd among 132 countries in the world and 27th among 41 countries with a high level of human development (Table 3). Slovakia has an overall GKI value of 55.85, which is 9 points higher than Ukraine and the global average.

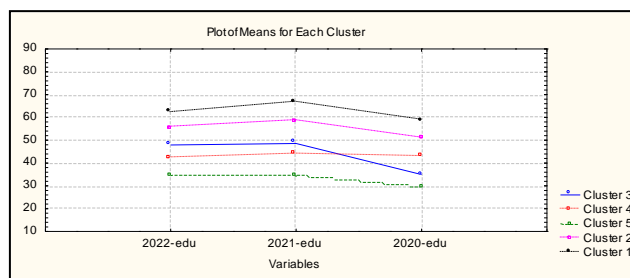
2. The subindex "Pre-university education" is most important for Ukraine and Slovakia. Because of this sub-index, both countries are included in the 15 countries in the world with a high level of population literacy, which ensures that these countries have an effective preschool and school education system. The index value for Ukraine is 1.7 points higher than in Slovakia.

3. All other sub-indices have different meanings for Ukraine and Slovakia. The sub-indices values for Ukraine are close to the world average. This indicates the need to direct government efforts to create conditions that stimulate the development of innovative information technologies and the expansion of colleges and technical schools to improve technical and vocational education and training. Unlike Ukraine, Slovakia has a well-structured system of secondary technical education, which allows the value of the sub-index "Technical and vocational education and training" to practically reach the highest level of this value in the United Arab Emirates (Table 9). 4 out of 7 sub-indices occupy an intermediate place between the world average and the highest values, which is evidence of the significant influence of knowledge on the development of all spheres of the country's society.

4. For Ukraine, the most significant gap is observed in the "Economy" sub-index (the value is 8 points lower than the world average). The reason for this situation in 2022 is Russian military aggression. However, analysis of this sub-index in 2020 shows that the situation was similar. Therefore, we can conclude that there are deeper reasons for Ukraine's low position. The Government of Ukraine should optimise tax legislation, strive to increase gross value added, look for ways to effectively use labour, stimulate the attraction of foreign direct investment, increase the openness of the national economy, and promote infrastructure investment. For Slovakia, the sub-index "Research, development and innovation" has the lowest value (the sub-index value is equal to the world average). Consequently, the country's government should create conditions to stimulate financing of R&D by firms, increase Gross domestic expenditure on R&D (GERD) as a percentage of GDP, strengthen international patent protection, facilitate access to technical information, etc.

The sub-index "Higher Education" is of particular interest to the study. The clustering of the analysed countries was carried out to determine the position of Ukraine and Slovakia on this sub-index. Figure 9 reflects the results of the partition quality, which also shows the high quality of homogeneity of the resulting groups of countries; Table 10 presents the results of the grouping of countries.

Cluster number	Cluster name	Cluster means
1	the highest level	58.7-67
2	high level	50-58.5
3	medium level	44.9-48.5
4	low level	42-44
5	the lowest level	29-34.5



a) Characteristics of cluster groups

b) graph of cluster averages

Figure 9. Characteristics and quality of cluster division for the sub-index “Higher Education”

Source: compiled by authors

Table 10. Grouping countries into clusters: the sub-index “Higher Education”

Cluster number	List of countries
1 cluster - the highest level	Sweden, Finland, Denmark, Netherlands, Norway, Canada, Germany, Australia, Switzerland, United States, United Kingdom, Belgium, Iceland, Austria, Estonia, Luxembourg, Portugal
2 cluster - high level	New Zealand, Ireland, Hong Kong, China, Spain, Singapore, France, Czech Republic, Israel, Slovenia, Italy, Malta, Lithuania, Slovakia , Cyprus, Poland, Latvia, Croatia, United Arab Emirates, Romania, Bulgaria, Qatar
3 cluster - medium level	Greece, Chile, Uruguay, Oman, Trinidad and Tobago, Belarus, Hungary, Mauritius, Panama, Ukraine , Georgia, Bosnia and Herzegovina, Armenia, Peru, Guyana, Lebanon, Albania, Botswana, Dominican Republic, Paraguay, Philippines, Bolivia, Cabo Verde, Indonesia, Ghana, Malawi
4 cluster - low level	Japan, Korea, Rep., Bahrain, Malaysia, Serbia, Saudi Arabia, Costa Rica, Russian Federation, Macedonia, FYR, Brazil, Argentina, Kuwait, South Africa, Mexico, Kazakhstan, Jordan, Colombia, Moldova, Tunisia, Azerbaijan, China, Kyrgyz Rep, Algeria, Egypt, Arab Rep, Ecuador, Pakistan, Tanzania, Lao PDR
5 cluster - the lowest level	Thailand, Turkey, Mongolia, Venezuela, RB, El Salvador, Iran, Islamic Rep., India, Kenya, Senegal, Uganda, Lesotho, Burkina Faso, Benin, Mali, Rwanda, Madagascar, Mozambique, Cambodia, Cameroon, Mauritania, Nepal, Cote d'Ivoire, Bangladesh, Ethiopia, Guinea, Angola, Myanmar

Source: compiled by authors

As the analysis shows, Ukraine and Slovakia occupy different positions: Slovakia entered the cluster with a high level of development of the HES, and Ukraine belongs to cluster 3, that is, a group of countries with an average level of development of the HES. For a more in-depth analysis of this sub-index, we will conduct a comparative analysis similar to the GKI analysis (Table 11).

Table 11. The values of the pillars of the “Higher education” sub-index: Ukraine, Slovakia and the highest level

Pillars	Level of Ukraine	Level of Slovakia	The highest level
Input	32.15	45.37	63.42 (Norway)
Learning environment	44.32	70.45	83.84 (Luxembourg)
Output	51.93	54.79	76.33 (Switzerland)

Source: The Global Knowledge Index, 2022

Analysis of the results obtained allowed us to draw the following conclusions:

1. The general position of Slovakia and Ukraine in the "Higher Education" sub-index among the 132 analysed countries is as follows:

- Slovakia ranks 26th (value 56.87) and belongs to the group of countries with a high level of development and the influence of the HES on the socioeconomic development of the country;
- Ukraine ranks 73rd (value 43.47). It is included in the group of countries with an average level of development of the HES and an average level of its influence on society and the economy.

2. The “Input” pillar reflects those factors that allow HES to achieve their development goals. These factors include various funding sources and human resources, including students and teachers. Ukraine has a value of 32.15 (rank 100), below the world average factor value. The country's government needs to pay attention to optimising the process of state financing of higher education, stimulating teachers to conduct research, and increasing the proportion of the population aged 18-24 years to enter HEI. Slovakia has a value of 45.37, slightly above the world average. The Slovak government needs to pay attention to government funding per student, encouraging applicants to enrol in undergraduate studies, and motivating teachers for scientific and technical research.

3. The “Learning environment” pillar includes factors related to academic freedom, equality, and inclusiveness of education. Ukraine has a value of 46.32 (rank 81), corresponding to the world average. The direction for further improving the country's position in this subindex is increasing gender equality among higher education teachers, expanding academic freedom at universities, and increasing the speed of incoming student mobility. Slovakia occupies a high position in this sub-index (value 70.45, rank 13), characterising a high level of academic freedom at universities, gender equality among university teachers, and a high level of incoming student mobility.

4. The "Outputs" pillar reflects the results of the HES's influence on graduates' economic condition and social status. Here, Ukraine (value 51.93) has problems with the employment of graduates, with the need to direct government efforts to stimulate interaction between universities and industry in the field of R&D and increase the citation rate of scientists' publications. Similar problems are inherent in Slovakia (value 54.79). The country has a low impact of higher education on the development of the economy and society, and it is also necessary to increase the percentage of graduates at both the bachelor's and master's levels. Thus, research has shown that Slovakia has a higher level of GKI and its sub-index "Higher education", making the Slovak Republic attractive to Ukrainian migrants.

Step 2.4. To determine the country's preference for population migration from Slovakia and Ukraine, we will compare clustering results by HDI and GII with the results of migration flows. Fig. 10 presents the results of the analysis for Ukraine.

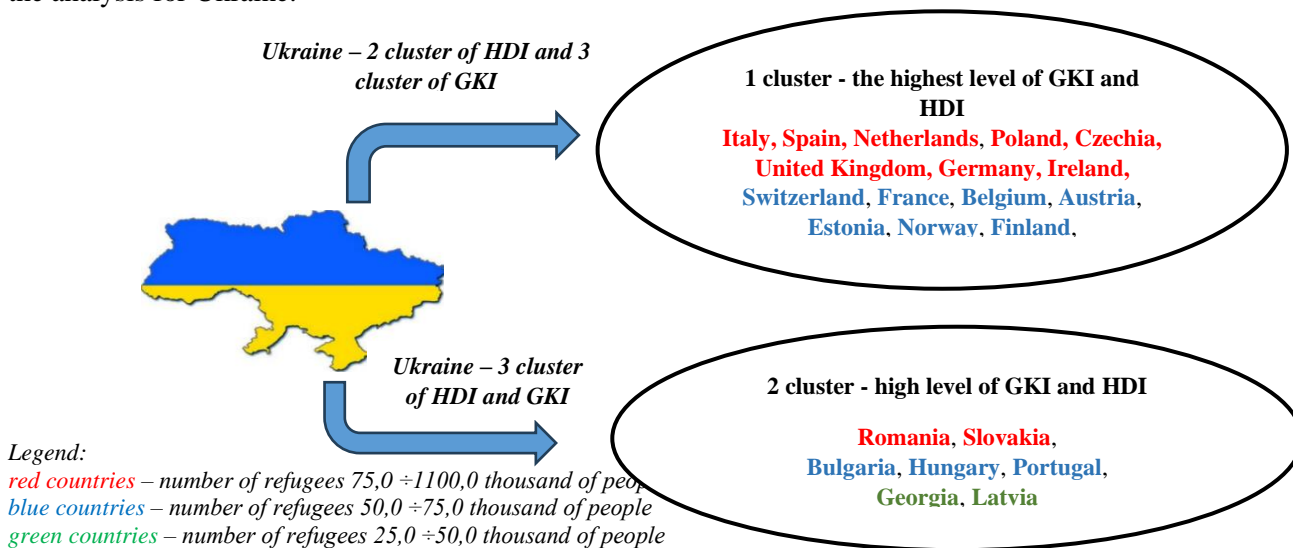


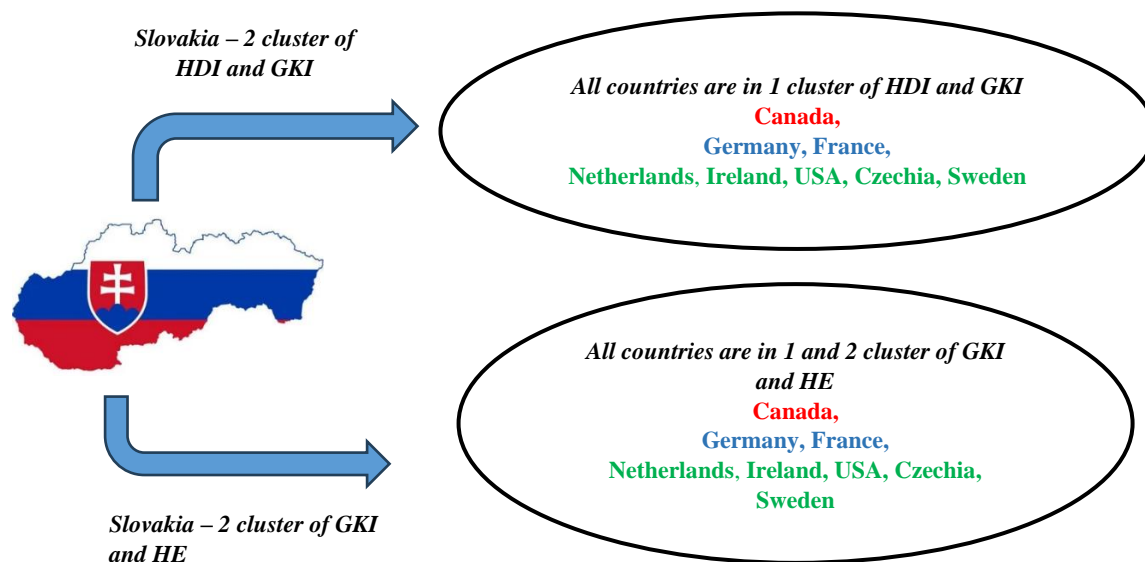
Figure 10. Migration of Ukrainians to countries around the world

Source: UN Refugee Agency, The GKI, 2000-2022; World Data Atlas, Human Development Index, 2000-2021, compiled by authors

As shown in Fig. 9, Ukrainian refugees choose countries with a higher level of development as their host country, not only for Ukraine but also for the world community (clusters 1 and 2). As noted above, a large proportion of migrants are people with professional and higher education who, when choosing a host country, want to have the opportunity to have decent employment (on a temporary or permanent basis). In addition, an analysis of the gender aspects of migration from Ukraine showed that the majority of refugees from Ukraine are

women with children of different ages who choose countries with a high level of education, including higher education. Mothers understand that a good education for their children is the key to the sustainability of their future lives.

Fig. 11 presents the results of the migration analysis for Slovakia.



Legend:

red countries – number of refugees and asylum-seekers more 10,0 thousand of people

blue countries – number of refugees and asylum-seekers 2,0 ÷ 4,0 thousand of people

green countries – number of refugees and asylum-seekers 0,3 ÷ 2,0 thousand of people

Figure 11. Migration of Slovaks to countries around the world

Source: UN Refugee Agency, The GKI, 2000-2022; World Data Atlas, Human Development Index, 2000-2021, compiled by authors

The analysis of migration from Slovakia allowed us to draw the following conclusions:

1. Slovaks, like Ukrainians, prefer to move to a place with a higher standard of living and quality of education. Since Slovakia belongs to cluster 2 (a group of countries with a high standard of living), migration goes to countries of clusters 1 and 2.

2. The migration process can be divided into 2 stages:

Stage 1 - 1994-2008: European countries were attractive, namely Germany, the Netherlands, Sweden, France, Denmark, Finland, Ireland, and France. Interest in moving to the US is growing;

Stage 2 – 2009 - 2021: there is a steady increase in migrants to France and the USA.

3. The most attractive country to live in is Canada. For the period 1994-2022. 12.130 people migrated to Canada.

Stage 3. Constructing a portrait and modelling trends in the development of transformation of the higher education system of Ukraine and Slovakia

Step 3.1. The attractiveness of a country's HES is a complexly structured concept that depends on many factors influencing it. The main factors include the quality of education, accessibility of education (primarily financial), the image of universities, promoting the mobility of students and teachers, the implementation of the national HES into the world system (comparability of degrees, the presence of three main cycles of education - bachelor's, master's, postgraduate, availability of the ECTS system, international recognition of diplomas and qualifications). In addition, the attractiveness of the HES has internal and external subsystems; that is, the assessment process should include indicators that reflect the level of attractiveness of the HES for the nation and for the international community.

The study identified such indicators as:

- to assess the *internal attractiveness of the HES*:

a) Share of schoolchildren enrolled in HEI, which is calculated using the following formula:

$$= \frac{\text{Share of schoolchildren enrolled in higher education institutions enrolment in tertiary education, all programmes, both sexes (number)}}{\text{School age population, tertiary education, both sexes (number)}}$$

b) Outbound mobility ratio, all regions, both sexes (%)

- to assess the *external attractiveness of the HES* - Inbound mobility rate, both sexes (%).

Sources of information are statistical data from the UNESCO Institute for Statistics and The World Bank for the period 2000-2022. Figures 12 and 13 show the trend of changes in indicators of the internal attractiveness of HES for Ukraine and Slovakia.

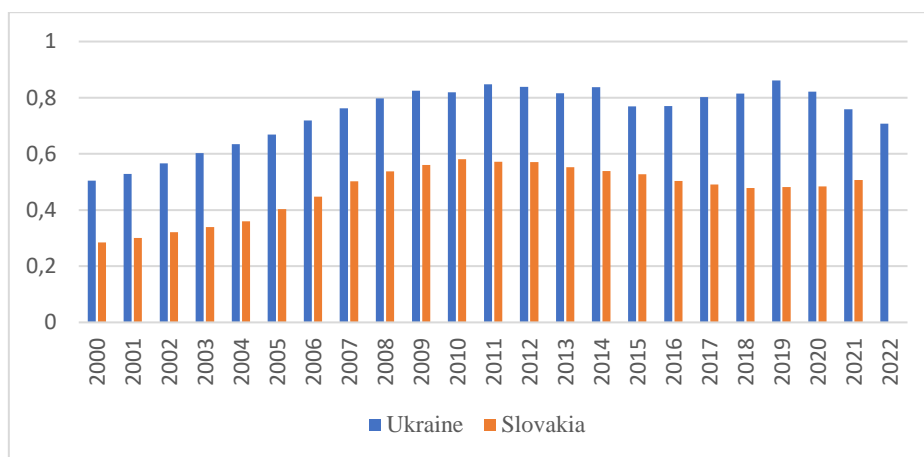


Figure 12. Dynamics of changes in the indicator Share of schoolchildren studying in HEI of Ukraine and Slovakia
Source: UNESCO Institute for Statistics, The World Bank, authors' calculations

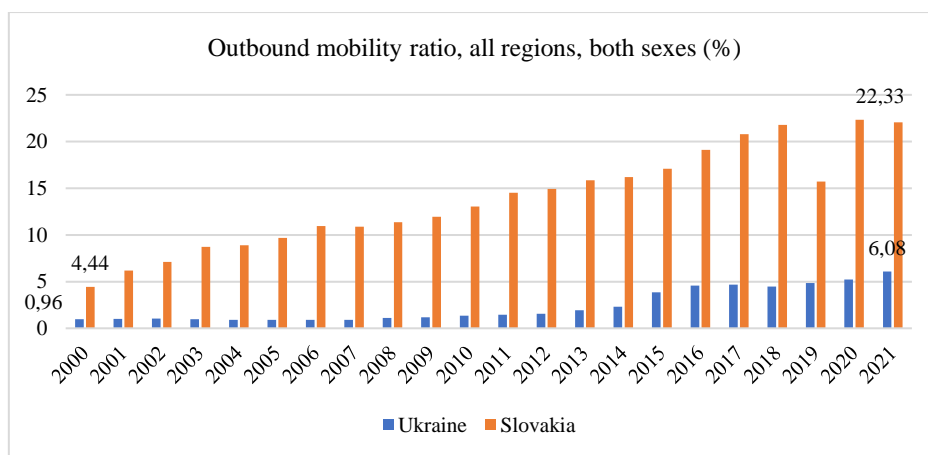


Figure 13. Dynamics of changes in the indicator Outbound mobility ratio, all regions, both sexes (%) of Ukraine and Slovakia
Source: UNESCO Institute for Statistics, The World Bank

Analysing the data in Fig. 12 and 13, the following conclusions are drawn regarding the internal attractiveness of HES countries:

1. In Ukraine, schoolchildren constitute the dominant age group of all applicants who enter universities. For 2000-2022, the share of schoolchildren varied in the range [0.5 ÷ 0.85]; the average value is 0.74. This means that 74% of university applicants are high school graduates. The dynamics of change in the indicator has a nonlinear, increasing trend with a growth rate of 1.4. That is, during the analysed period, the value of this

indicator increased by 40%, which indicates an increase in the internal attractiveness of higher education in Ukraine.

2. In Slovakia, the attractiveness of higher education among schoolchildren is, on average 40% lower than in Ukraine. For the period 2000-2022, the average value of the indicator is 0.47, the range of changes in its values is [0.28 ÷ 0.58]. This is proof that less than half of schoolchildren see the need to obtain higher education for their future development. Despite this, the trend of change in the indicator is also upward; the growth rate is 1.8, indicating an increase in higher education attractiveness for school graduates.

3. The outbound student mobility indicator reflects the percentage of students in a country who went abroad to obtain an education out of the total number of students studying at universities in their home country. Suppose changes in this indicator are characterised by either large volumes of students or increasing trends. In that case, the attractiveness of the country's HES is falling, which poses a threat to the activities of higher education institutions. During the analysed period, a trend towards increasing values of this indicator was formed in Ukraine and Slovakia. However, the qualitative characteristics of these trends are different. In Slovakia, the percentage of outgoing students increased 5 times and in 2021 amounted to 22.06% of the total number of students studying at universities in the country (a fifth of all students in the country); in Ukraine, the growth rate of the indicator was 6.3 and in 2021 reached the level of 6.1%, which is 4 times less than in Slovakia. Consequently, despite the homogeneity of the indicator trends, the attractiveness of the Ukrainian HES is higher than that of the Slovak HES for national students.

Figure 14 shows the dynamics of the external attractiveness indicator HES of Ukraine and Slovakia - Inbound mobility rate, both sexes (%).

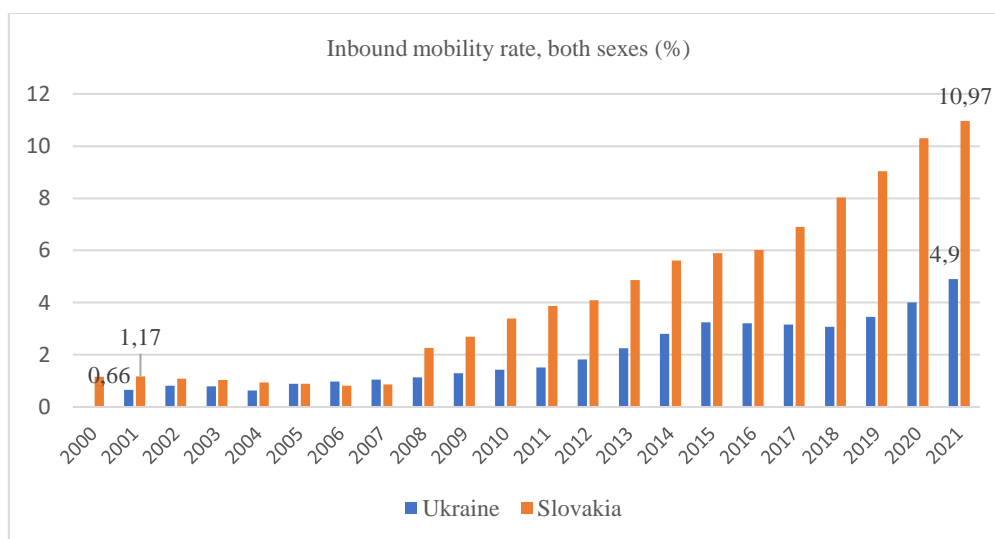


Figure 14. Trends in the external attractiveness of HES in Slovakia and Ukraine
 Source: UNESCO Institute for Statistics, The World Bank

This indicator shows the number of foreign students who study in the country, of the total number of all students, expressed as a percentage. This indicator is a key indicator of the attractiveness of the country's HES, latently reflects the quality of education and requires constant monitoring by the state and the individual university. Data analysis shows that the external attractiveness of HES in Slovakia for 2021 is 2 times higher than in Ukraine. Slovakia and Ukraine have homogeneous, increasing trends in this indicator, which can be divided into two stages:

Stage 1 – 2000 – 2007. The value of the indicator is low; for the two countries, they change in the same range [0.7 – 1.1], which characterises a rather low level of attractiveness of HES countries for foreign students;

Stage 2 – 2008 – 2021. A tendency has emerged for a significant increase in incoming students. For Slovakia, the number of foreign students increased 5 times, and for Ukraine – 6 times. As of 2021, 11% of foreign students

from the total number of students in the country studied in Slovakia; in Ukraine, the indicator value reached 5%. It should be noted that 2022 has significantly changed these trends, associated with the Russian and Ukrainian conflict and a significant increase in migration flows to Europe, which requires additional study.

Step 3.2. To effectively manage structural and qualitative changes in the country's HES, it is necessary to permanently monitor the factors that provoke these changes and have effective tools for their analysis and modelling (Hypothesis 4, 5). The study proposes the use of an integral indicator to assess the level of HES development of a country, which is calculated based on the following indicators: Enrolment in tertiary education, all programs, both sexes (number), Gross enrolment ratio for tertiary education, both sexes (%), Inbound mobility rate, both sexes (%), Percentage of enrolment in tertiary education in private institutions (%), School life expectancy, tertiary, both sexes (years), Teachers in tertiary education programs, both sexes (number), Government expenditure on tertiary education as a % of GDP (%), Initial government funding per tertiary student as a percentage of GDP per capita, School age population, tertiary education, both sexes (number), percentage of schoolchildren enrolled in higher education institutions. The calculations are based on statistical information from the UNESCO Institute for Statistics and the World Bank for the period 2000-2020.

Figure 15 shows the trend in this indicator for Slovakia and Ukraine. Calculations were carried out in Statistica 11.0 software.

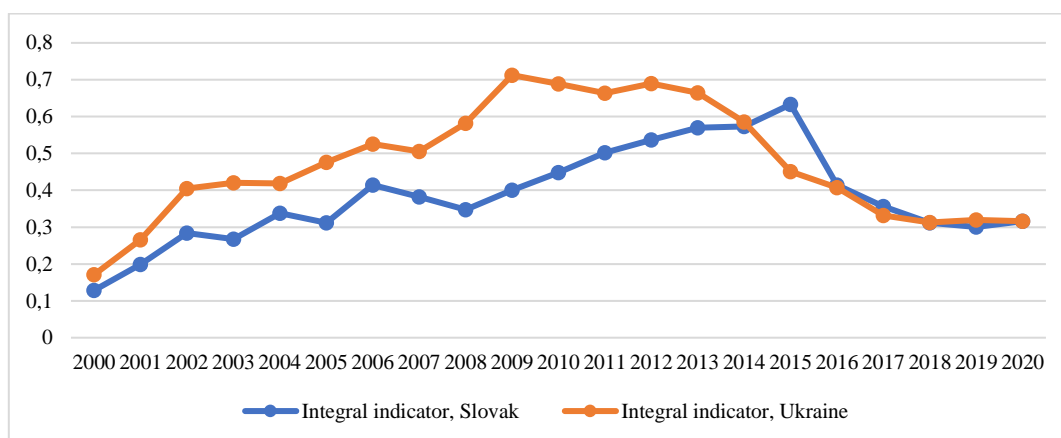


Figure 15. Dynamics of changes in the integral indicator of the attractiveness of HES in Slovakia and Ukraine
Source: compiled by authors

Changes in the integral indicator of the level of development of the attractiveness of HES countries have a unidirectional trend at high values of the indicator, which characterises a fairly high level of quality of the education system of Ukraine and Slovakia. The values of the integral indicator vary in the range: for Slovakia [0, 13 ÷ 0.63]; for Ukraine [0.17 ÷ 0.71].

For Ukraine, HES remains the country's key competitive advantage despite the high political and economic instability. The strengths of HES are funding from government and non-government sources. Thus, the average value of the indicator Government expenditure on tertiary education as a % of GDP (%) for the period 2000-2020 in Ukraine is 1.7%, which is 50% higher than in Slovakia (for Slovakia - 0.86%); and the value of the indicator Initial government funding per tertiary student as a percentage of GDP per capita in Ukraine is 36% higher than in Slovakia. In Ukraine, compared to Slovakia, the indicator value Percentage of schoolchildren enrolled in higher education institutions is 38% higher, 43% higher than the value of the Gross enrolment ratio for tertiary education, both sexes indicator (%).

Slovakia's strength is the external attractiveness of its HES. The values of the indicator Inbound mobility rate, both sexes (%) on average for the period 2000-2020 are 2 times higher than in Ukraine; high values of the indicator Percentage of enrolment in tertiary education in private institutions (%) are observed.

Step 3.3. Using a taxonomic integral indicator as a tool for assessing the country's HES development trends allows the diagnosis of these trends and the modelling of the development process based on economic dynamics methods. Since this indicator varies from 0 to 1 and the higher its value towards 1, the higher the attractiveness and quality of the country's HES, researchers can unambiguously interpret the prospect of changes in its values. Analysis of the dynamics of the integral indicator for Slovakia and Ukraine allowed us to draw a conclusion about the nonlinear nature of its changes, which, in turn, suggests the possibility of using nonlinear models to predict the values of the integral indicator.

In the study, using Statistica 11.0, a series of model experiments were carried out, resulting in the best model for short-term adaptive forecasting - the exponential smoothing model. Table 12 presents the calculation results and criteria for the approximation quality.

Table 12. Results of modelling the integral indicator of the attractiveness of HES in Ukraine and Slovakia

Model	MAPE	Forecast
Ukraine		
Exponential smoothing, Damped trend, no season, Alpha=1,0 Gamma=0,084 Phi=0,803	10.5%	0.31 (2021)
Slovakia		
Exponential smoothing, Damped trend, no season, Alpha=0,51 Gamma=1,0 Phi=0,355	15.3%	0.305 (2021)

Source: compiled by authors

As calculations have shown, the values of the integral indicators for Slovakia and Ukraine are almost the same (0.305 and 0.31, respectively), reflecting the formation of a stable trend over the past 4 years. These indicator values correspond to the average level of attractiveness of HES, which poses the challenge for universities in countries to increase their innovative and entrepreneurial activities, actively implement information and communication technologies, search for new interactive learning methods, etc.

However, the following should be noted. Russian aggression against Ukraine has significantly changed the development trends of countries, causing a substantial fluctuation in the form of mass migration of Ukrainians to Europe, including Slovakia. Therefore, forecasting trends in the attractiveness of HES requires additional research, model experiments and the search for special forecasting methods that can consider the high stochasticity of the external environment.

Conclusions

The conducted research allowed us to draw the following conclusions:

1. The current stage of development of the HES of the world and countries is characterised by serious changes caused by global political and economic instability and the rapid diffusion of information technologies into all spheres of society and the economy. In this regard, universities are faced with the need to transform a traditional university into a digital university of an innovative and entrepreneurial type. This requires a constant search for funding sources for its activities based on improving the quality of scientific and educational processes, forming a national and international image of the university, and close contact with the main stakeholders. Achieving these goals involves constant monitoring of the current and future needs of the labour market, priority trends in the development of civilisation and national economies, and the search for effective approaches, methods and methods of educational, scientific and practical activities.

2. It is substantiated that migration processes significantly impact the development of HES countries. They can either increase or decrease the attractiveness of HES. The results showed that the level of quality of life and the quality of education, in particular higher education, play a key role in the choice of migration preferences of the population. The study used international indices, namely HDI, GKI, and HE sub-index, to assess the migration of Slovaks and Ukrainians. According to the index, Ukraine and Slovakia occupy consistently high positions

and are in a cluster with a high quality of life and education. At the same time, these countries' populations choose countries with the highest levels of these indices to move to another country.

3. An analysis of global migration trends was carried out, and it was determined that migration has an increasing trend. This means that in the context of globalisation, the population is moving to countries with higher quality of life in search of decent work, high-quality education, and a safe life. An analysis of the migration preferences of the population of Slovakia and Ukraine allowed us to conclude that there is a growing trend in migration. For Ukraine, migration over the last two years has been forced, which is due to military aggression from Russia.

4. An assessment of the internal and external attractiveness of HES Ukraine and Slovakia was carried out. The results showed that Slovakia has a higher level of external attractiveness of HES, and Ukraine ranks high in internal attractiveness of HES.

5. To assess and predict the attractiveness of HES countries, the study proposes an integral indicator of the level of development. It identifies trends in the development of HES in Ukraine and Slovakia. The results showed that changes in integral indicators have the same nonlinear development trend. The relevance of using adaptive short-term forecasting models, namely the exponential smoothing model, was proven based on model experiments. The models built for the countries are of high quality, which made it possible to obtain predictive values of the attractiveness of HES.

Further areas of research are related to a more in-depth study of the characteristics of educational migration, its impact on the economic development of donor and recipient countries, the choice of methods and models for forecasting highly fluctuation processes, reflecting the political and economic instability of global and regional development, with the search for ways to overcome challenges, that they face the HES.

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