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ECONOMETRIC ANALYSIS OF THE DYNAMICS OF EDUCATIONAL MIGRATION OF UKRAINIAN CITIZENS TO EUROPEAN COUNTRIES UNDER THE CONDITIONS OF FULL-SCALE WAR

ЕКОНОМЕТРИЧНИЙ АНАЛІЗ ДИНАМІКИ ОСВІТНЬОЇ МІГРАЦІЇ ГРОМАДЯН УКРАЇНИ ДО КРАЇН ЄВРОПИ В УМОВАХ ПОВНОМАСШТАБНОЇ ВІЙНИ

Iurchenko Maryna
Associate Prof., Researcher, Department of Informatics and Statistics,
Klaipeda University, Lithuania
ORCID: https://orcid.org/0000-0001-8992-6093

Ponomarenko Maryna
Associate Prof, Researcher, Department of Social Geography and Tourism,
Klaipeda University, Lithuania
ORCID: https://orcid.org/0000-0002-2406-408X

Юрченко Марина Євгеніївна, Пономаренко Марина Валентинівна
Університет м. Клайпеда, Литва

The article analyzes the dynamics of educational migration of Ukrainian citizens to European countries during the full-scale war. The events of 2022 triggered large migration flows that affected educational systems in EU countries. A significant share of forced migrants are school pupils and students, leading to new patterns of educational mobility and integration of Ukrainian learners into the European educational space. The study aims to identify key trends in educational migration and assess factors influencing the number of Ukrainian students in host countries. The empirical basis includes data from Eurostat, UNHCR, OECD and national statistics for 2022-2025. Correlation analysis and linear and multiple regression models are applied. The results show a positive relationship between school educational migration and the number of Ukrainian university students, indicating stable educational migration trajectories.

Keywords: forced migration; educational integration; EU temporary protection; Ukrainian students; school adaptation; academic mobility.

У роботі проведено економетричний аналіз динаміки освітньої міграції громадян України до європейських країн в умовах повномасштабної війни. Воєнні події, що розпочалися у 2022 році, спричинили масштабні міграційні процеси, які суттєво вплинули на функціонування освітніх систем країн Європейського Союзу. Значну частку вимушених мігрантів становлять школярі та студенти, що зумовило формування нових моделей освітньої мобільності та інтеграції українських учнів у європейський освітній простір. За цих умов особливої актуальності набуває аналіз факторів, що визначають динаміку освітньої міграції та довгострокові наслідки перерозподілу людського капіталу. Метою дослідження є виявлення ключових тенденцій освітньої міграції українських учнів у країнах Європи та оцінка факторів, що впливають на чисельність українських студентів у країнах прийому. Емпірична база дослідження сформована на основі даних Eurostat, UNHCR, OECD та національної статистики європейських країн за період 2022-2025 рр. У роботі використано методи статистичного та економетричного аналізу, зокрема кореляційний аналіз, лінійне та множинне регресійне моделювання. Як залежну змінну в моделі розглянуто чисельність українських студентів, які навчаються в університетах європейських країн, тоді як незалежними змінними виступають часовий фактор та чисельність українських школярів, інтегрованих до освітніх систем країн прийому. Результати економетричного аналізу свідчать про наявність статистично значущого позитивного взаємозв'язку між масштабами шкільної освітньої міграції та кількістю українських студентів. Це підтверджує формування стійких освітніх траєкторій міграції, за яких країни, що приймають значну кількість українських школярів, згодом стають центрами продовження

здобуття вищої освіти. Отримані результати дають підстави розглядати освітню міграцію як багаторівневий процес, що включає взаємопов'язані потоки шкільної та університетської мобільності. Міжнародні програми підтримки Європейського Союзу, зокрема Erasmus+ та Horizon Europe, відіграють важливу роль в інтеграції українських учнів до європейського освітнього простору та сприяють збереженню наукового й освітнього потенціалу України.

Ключові слова: вимушена міграція; освітня інтеграція; тимчасовий захист ЄС; українські студенти; шкільна адаптація; академічна мобільність.

Statement of the problem. The full-scale war in Ukraine that began in 2022 has triggered the largest wave of forced migration in Europe since the Second World War. Millions of Ukrainian citizens received temporary protection status in the countries of the European Union, which led to a significant redistribution of human capital, including school pupils, university students, and academic staff. These processes have caused structural changes in the national education system and intensified the processes of transnational educational mobility of Ukrainian learners.

Unlike classical educational migration, educational migration during wartime combines forced displacement, rapid integration into the educational systems of host countries, and the continuation of studies under the Ukrainian educational curriculum in an online format. This has created a new phenomenon of "dual education", in which Ukrainian learners are simultaneously involved in the educational systems of several countries. Under these conditions, educational integration becomes an important mechanism of social adaptation, but at the same time increases the risk of educational and intellectual capital outflow from Ukraine.

The current situation creates a number of contradictions. Temporary protection status is gradually acquiring the characteristics of long-term migration, which increases the risk of educational losses and the outflow of scientific personnel. At the same time, the pressure on both the educational systems of host countries and Ukrainian educational institutions is increasing. Meanwhile, educational migration contributes to the redistribution of knowledge, skills, and research potential between countries, generating both "brain drain" and "brain circulation" effects.

Thus, the educational migration of Ukrainian citizens can be considered as a factor of structural transformation of the educational systems of Ukraine and the European Union countries, requiring a comprehensive analysis of integration mechanisms and long-term implications for the formation and preservation of human capital.

Analysis of resent research and publications. Educational migration under forced displacement has been examined through human capital theory, transnational mobility, and brain drain. Yet studies focused specifically on wartime educational migration remain scarce, and the full impact of the post-2022 forced migration of Ukrainians on both host-country education systems and Ukraine's own system is still insufficiently studied.

A substantial body of research addresses the theoretical foundations of brain drain. T. Li [1] systematizes its definitions, indicators, and causes through the push-pull framework. Brain drain is generally understood as the migration of highly educated and skilled people to more developed countries in search of better living and working conditions (Aydınbaş et al. [2]). Empirical studies confirm the importance of macroeconomic determinants: Akyıldız et al. [3] show that macroeconomic conditions strongly influenced brain drain in Turkey during 1984-2022. Other research stresses organizational causes, including weak management, limited career prospects, and low wages (Miller et al. [4]). Scholars increasingly view brain drain as a global rather than purely national phenomenon. T. Nguyen [5] argues that global competition for highly skilled professionals has intensified. Major drivers include low incomes, political instability, restricted employment opportunities, security risks, corruption, and better educational and professional prospects abroad (S. Kohi [6]). To reduce brain drain, researchers propose education reform, stronger meritocracy, and greater support for science and researchers (P. Singh [7]). The search for better education also encourages many educational migrants to remain in host countries after graduation and continue their careers there (M. Mustika and N. Yuliarmi [8]).

The economic effects of brain drain are also widely discussed. Using ARDL methodology, M. Radulović [9] finds an asymmetric effect in 25 OECD countries during 2006-2022: the emigration of highly skilled workers slows growth in origin countries while supporting growth in destination countries. At the same time, recent

literature increasingly highlights brain circulation, emphasizing the positive role of diasporas, knowledge transfer, and return migration.

For Ukraine, I. Nikolina et al. [10] analyze wartime education policies aimed at counteracting brain drain and note the absence of a systematic strategy. They stress the need for mechanisms to attract and return specialists and compare Ukraine's case with countries previously affected by armed conflict. In the broader European context, Jansen et al. [11], studying the Western Balkans, show that talent outflow can seriously impede economic recovery and EU integration, and they recommend incorporating brain drain prevention into EU enlargement policy while shifting attention toward brain circulation. Other studies suggest that highly skilled migration is not always an irreversible loss. Batista et al. [12] argue that migration opportunities can stimulate investment in education and increase human capital through remittances, diaspora networks, and knowledge exchange. Beine et al. [13] likewise show that migration prospects may encourage educational investment, although overall effects for developing countries remain mixed. Another major issue is the lack of comprehensive mobility data. Akbaritabar et al. [14] stress the importance of reliable migration statistics and present a global database of researcher migration flows based on Scopus and OpenAlex. Finally, P. Altbach [15] notes that international academic mobility is central to modern scientific careers, but Europe faces serious talent-loss risks driven by higher salaries abroad, insecure short-term contracts, unfair hiring, and attractive migration policies elsewhere.

Overall, existing research clarifies many causes and consequences of brain drain and academic mobility. However, the specific features of educational migration during war and its long-term effects on educational-system transformation remain insufficiently explored, underscoring the need for further research.

Highlighting previously unresolved parts of the overall problem. Despite the considerable number of studies devoted to educational migration and the phenomenon of brain drain, several aspects of this problem remain insufficiently explored. In particular, limited attention has been paid to the analysis of educational migration under conditions of armed conflict and its impact on the transformation of educational systems in both origin and host countries. The relationship between school and university educational migration, as well as the factors shaping stable educational migration trajectories, also remains insufficiently studied. In addition, there is a lack of comprehensive econometric analysis of the dynamics of educational migration of Ukrainian citizens following the outbreak of the full-scale war in 2022. Therefore, further research is needed to identify the main trends and determinants of the educational mobility of Ukrainian learners in European countries.

Formation of the objectives of the article (task statement). The aim of the article is to conduct an econometric analysis of the dynamics of educational migration of Ukrainian citizens to European countries under the conditions of the full-scale war. The study is aimed at identifying key trends in the educational mobility of Ukrainian schoolchildren and students in European countries during the period 2022-2025. Particular attention is given to the analysis of factors determining the number of Ukrainian students in host countries, as well as to identifying the relationship between school and university educational migration. The study applies correlation and regression analysis methods to assess statistical relationships between the main indicators of educational migration. The results of the research make it possible to identify the features of the integration of Ukrainian learners into the European educational space and to evaluate the long-term implications of these processes for the formation and preservation of Ukraine's human capital.

Summary of the main research material. Armed conflicts have a significant impact on educational mobility and academic migration. A comparison of educational migration from Ukraine after 2022 and the migration processes caused by the Balkan conflicts in the 1990s makes it possible to identify common patterns and differences in the transformation of educational systems under crisis conditions. During the war in the former Yugoslavia (1991-2001), a large number of students and scholars left the region. Universities in Bosnia and Herzegovina, Croatia, and Serbia faced the destruction of infrastructure and a reduction in academic staff. As a result of the military actions, students continued their studies at universities outside their home countries.

It should be noted that after the beginning of the full-scale war in Ukraine in 2022, a significant increase in educational migration was also observed; however, there are substantial differences between these migration waves. During the Balkan conflicts, migration was

predominantly student and academic in nature, while the migration of schoolchildren was less significant. Since the start of the full-scale war in Ukraine, in contrast to the Balkans, migration has been predominantly school-based. Another important difference is the level of institutional support for educational migrants, since in the 1990s international educational programs were limited and support was provided mainly through individual initiatives of specific educational institutions.

In the case of Ukraine, the European Union has implemented large-scale support programs, including Erasmus+, MSCA4Ukraine, Scholars at Risk Europe, Horizon Europe support actions, and others, which have significantly facilitated the integration of Ukrainian students and researchers. Significant differences are also observed in the geographical structure of educational migration. During the Balkan conflicts, the main destinations for educational migrants were Germany, Austria, Italy, and the United States. For Ukrainian educational migrants, the key destination countries have become Germany, Poland, the Baltic states, and Czechia.

European countries are implementing various support programs for Ukrainian pupils and scholars, including integration into school systems, the provision of university scholarships, and participation in international research projects [20]. As a result, a new structure of educational migration is emerging, which differs significantly from pre-war models of academic mobility. Figure 1 presents data on the structural distribution of Ukrainian educational migrants by levels of education.

The largest share is represented by school pupils-approximately 480 thousand individuals (84.7%). This is explained by the fact that the majority of forced migrants consist of families with school-age children who have been integrated into the educational systems of European countries. The growth of student mobility (approximately 75 thousand individuals) is associated with students' participation in international educational programs as well as with expanded opportunities for studying at European universities. The smallest share of educational migration is represented by researchers (around 12 thousand individuals). At the same time, this group plays an important role in the development of international scientific cooperation and the implementation of joint research initiatives.

Figure 2 presents the distribution of Ukrainian researchers participating in major European academic support programs during the period 2022-2025. The first graph illustrates the dynamics of Ukrainian researchers' participation in European support programs over this period. In 2023, a significant increase in the number of researchers involved in European academic initiatives can be observed, which is associated

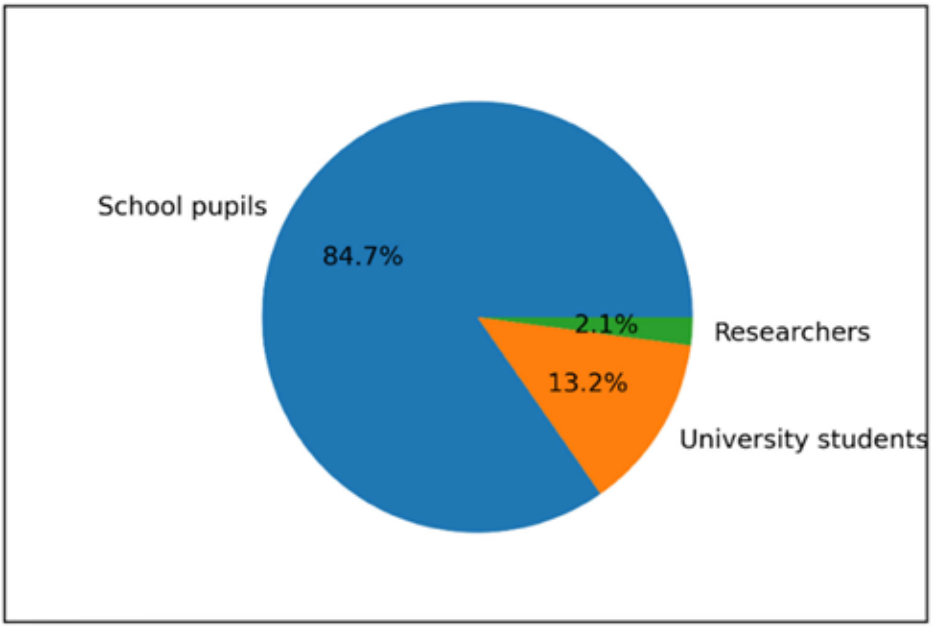
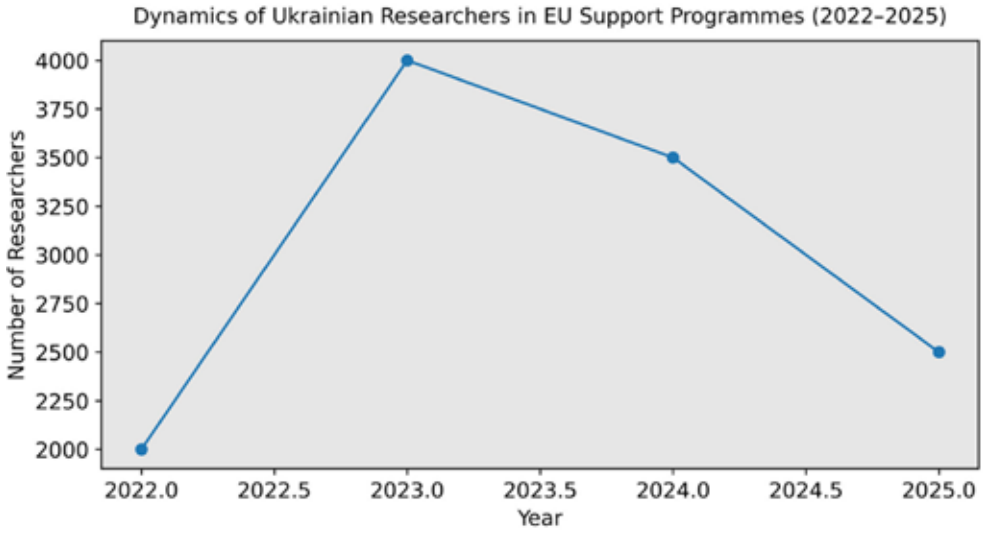
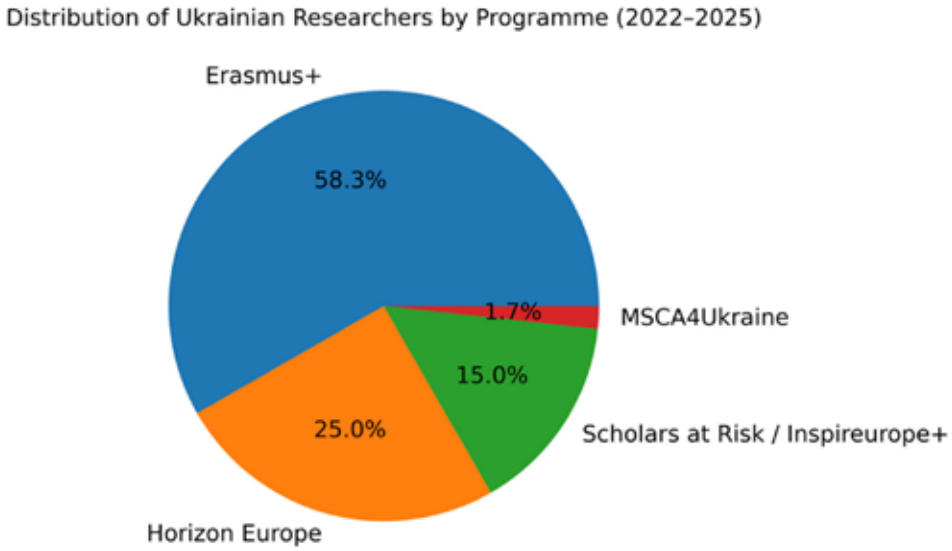


Figure 1. Educational structure of Ukrainian academic migration in Europe (2025)

Source: formed by the authors based on [16-22]





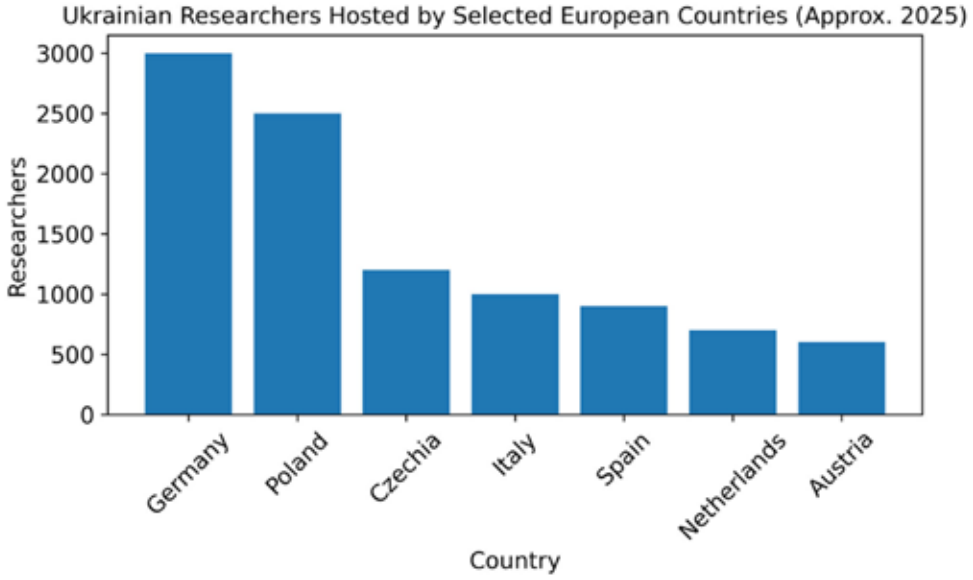


Figure 2. Participation of Ukrainian researchers in European academic support programmes (2022-2025)

Source: formed by the authors based on [16-22]

with the launch of new support programs and expanded opportunities for Ukrainian scholars to participate in international research projects.

According to the data presented in sources [1822], the largest number of Ukrainian researchers are located in Germany and Poland, which have become the main centers of academic integration for Ukrainian scholars. A considerable number of researchers are also employed at universities and research institutions in Czechia, Italy, Spain, the Netherlands, and Austria.

The analysis of the dynamics of the number of Ukrainian schoolchildren in European countries during the period 2022-2025 (Figure 3) shows a significant increase in the main host countries. The largest growth is observed in Poland: the number of pupils increased from approximately 120 thousand in 2022 to more than 250 thousand in 2025. Germany also shows an increase, although the dynamics are more moderate-from about 200 thousand to more than 220 thousand pupils.

In Czechia, the number of Ukrainian schoolchildren remains relatively stable, fluctuating between 47 and 53 thousand. In Lithuania, the figures are significantly lower; however, a gradual increase in the number of pupils can be observed, which is partly related to the establishment of educational institutions for Ukrainian children. In 2022, with the support of the Embassy of Ukraine, the International Ukrainian School was opened, operating under the Ukrainian educational curriculum. Branches of this school operate in several cities across the country, including Vilnius, Kaunas, Klaipėda, Šiauliai, and Panevėžys. Several thousand Ukrainian schoolchildren study in these educational centers, which helps preserve the Ukrainian educational program and facilitates the integration of children into the educational system of the host country.

In Southern European countries such as Italy and Spain, a steady increase in the number of Ukrainian schoolchildren has been observed throughout the entire period under consideration. In Romania and Norway, the figures remain relatively low; however, they also demonstrate positive dynamics.

According to the data presented in sources [19; 20], an analysis of the dynamics in the number of Ukrainian students in European countries during the period 2022–2025 shows that the highest concentration is observed in Poland, where their number increased from approximately 35 thousand in 2022 to around 50 thousand in 2025. Germany ranks second, demonstrating a gradual increase in the number of students from about 7 thousand to approximately 10 thousand.

In Central European countries such as Czechia and Lithuania, positive dynamics are also observed, although the absolute

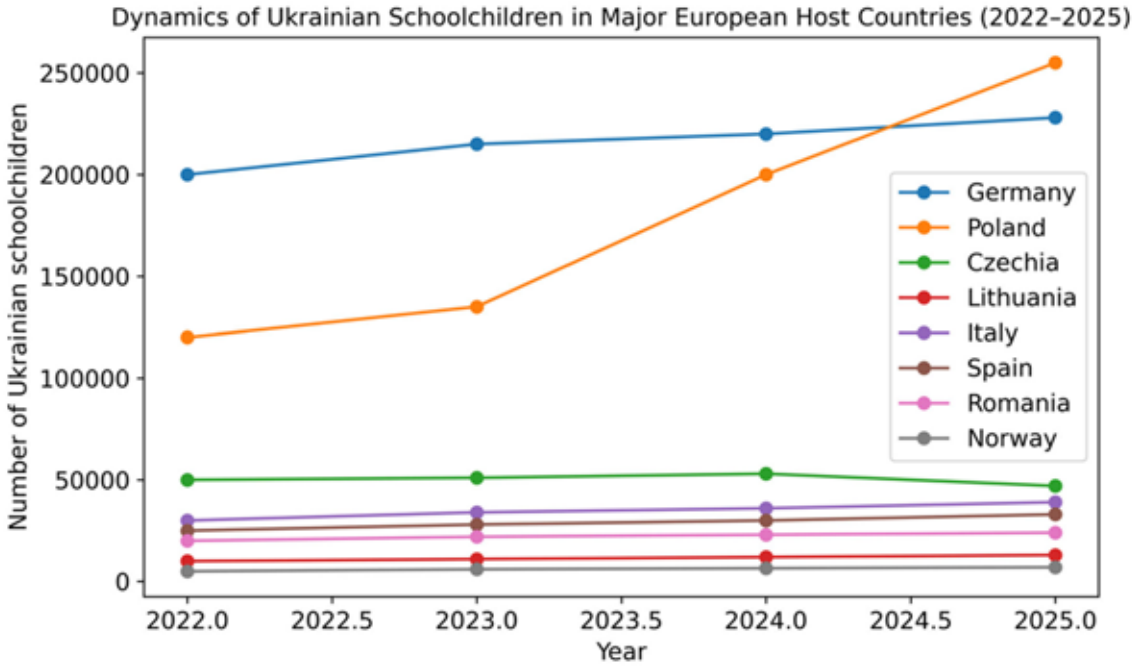


Figure 3. Dynamics of Ukrainian schoolchildren enrolled in schools in major European host countries (2022-2025)

Source: *formed by the authors based on [16-22]*

figures remain significantly lower. In Southern European countries-Italy and Spain-the growth in the number of Ukrainian students is more moderate but stable throughout the observed period. Romania and Norway are characterized by relatively small numbers of Ukrainian students; however, a gradual increase can also be observed in these countries. Overall, the dynamics indicate the expansion of the academic mobility of Ukrainian students and their gradual integration into the European educational space.

To assess the relationship between the indicators of educational migration, the Pearson correlation coefficient is used:

$$r = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2}\sqrt{\sum_{i=1}^{n}(y_i - \bar{y})^2}}$$

x_i – values of the first variable (for example, the year of observation)

y_i – values of the second variable (for example, the year of students)

$\bar{x}$ – the mean value of the variable

$\bar{y}$ – the mean value of the variable

n – the number of observations.

The calculations of the Pearson correlation coefficient show that for most of the countries considered, its values lie within the range

$$0.93 \le r \le 0.99,$$

which corresponds to a very strong positive linear relationship between the time factor and the number of students. The high values of the correlation coefficient confirm a steady increase in the indicators of educational migration. In particular, for Germany the value of the correlation coefficient between the year of observation and the number of Ukrainian students is $r \approx 0.98$, which indicates an almost linear relationship between the increase in the time period and the growth in the number of students. A similar situation is observed in Poland, where $r \ge 0.95$.

In addition, the analysis of the relationship between the number of school pupils and university students shows a positive correlation, which indicates the formation of stable educational centers of Ukrainian migration. This means that countries hosting a significant number of Ukrainian schoolchildren subsequently become the main centers of higher education for Ukrainian students. The high values of the correlation coefficients make it possible to conclude that the integration of Ukrainian learners into the European educational space has a structural character.

From the perspective of statistical analysis, the observed dynamics can be described as a monotonically increasing function of time, indicating the long-term nature of the identified processes of educational mobility.

To analyze the dynamics in the number of Ukrainian students in host countries, a linear regression model of the time trend is used:

$$y_t = a + b \cdot t + \varepsilon_t,$$

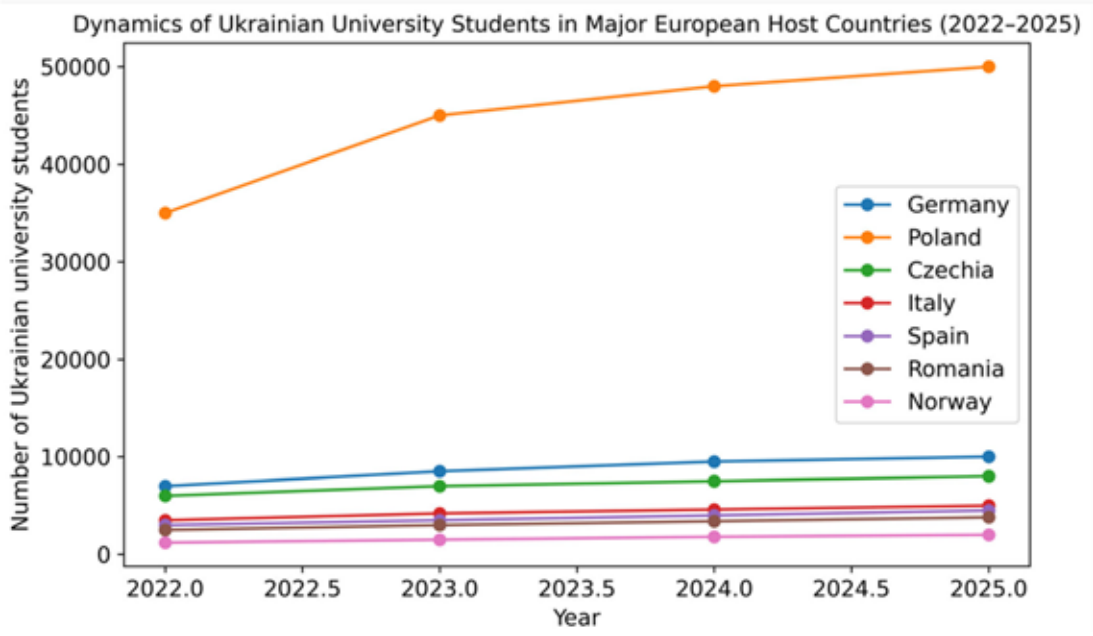


Figure 4. Dynamics of Ukrainian university students in major European host countries (2022-2025)

Source: formed by the authors based on [16-22]

where y_t – the number of Ukrainian students (school pupils or university students) in year t, a – the intercept, b – the trend coefficient reflecting the average annual change in the indicator, ε_t – the random error (residual). The model parameters are estimated using the ordinary least squares (OLS) method. The goodness of fit of the trend is assessed using the coefficient of determination. R^2. The calculated results are presented in Table. 1

The results of the regression analysis presented in Table 1 show that in all models the trend coefficient $b > 0$, which indicates a steady increase in the number of Ukrainian schoolchildren and students in host countries during the period 2022-2025. The high values of R^2 (0.87-0.97) suggest that the linear model adequately describes the dynamics of the indicators and reflects the structural nature of the growth.

The highest growth rate is observed among schoolchildren in Poland, confirming the country's role as the main center of educational integration for Ukrainian children. In Germany, the growth is more moderate but stable $(b = 46.500)$ persons per year for schoolchildren and $b = 1000$ persons per year for students. In other EU countries (Italy, Spain, Romania, Lithuania, and Norway), positive trends are also observed; however, their scale is significantly lower, indicating a more limited role of these countries in the redistribution of educational migration from Ukraine.

The relatively lower R^2 value for students in Poland (0.866) may reflect greater variability in the data series and the influence of additional factors, including changes in admission policies, the redistribution of educational flows within the EU, and return migration. The comparison of trend coefficients shows that the concentration of school migration is significantly stronger than that of student migration, both in terms of growth rates and the scale of migration flows. Such a structure corresponds to the characteristics of forced migration, in which a substantial proportion consists of families with children. The obtained coefficients indicate a statistically significant positive relationship between time and the number of Ukrainian students. The positive coefficient of the *Year* variable indicates a steady increase in the academic mobility of Ukrainian students in European countries during the period 2022-2025. This result reflects the expansion of opportunities for Ukrainian citizens to study at universities in the countries of the European Union, as well as active support from international educational programs.

The correlation matrix demonstrates a high level of interconnection between the indicators of educational migration of Ukrainian schoolchildren and students in European countries. Most correlation coefficients fall within the range of 0.85-0.99**,** indicating a strong positive relationship between the dynamics of educational migration across different countries. Lower values are observed for Czechia, which is associated with fluctuations in the number of Ukrainian schoolchildren during the period under consideration.

Conclusions. The obtained research results allow several important conclusions to be drawn regarding the development of educational migration of Ukrainian learners to European countries under conditions of war and crisis. Statistical and econometric analysis confirms the presence of a steady upward trend in the number of Ukrainian schoolchildren and students within the educational systems of European countries during the period 2022-2025. This dynamic

Table 1

Regression analysis of educational migration trends of Ukrainians (2022–2025)

Country	Schoolchildren			University students		
	a (intercept)	b (per year)	R^2	a (intercept)	b (per year)	R^2
Germany	-17,187	8,600	0.971	-2,014	1,000	0.952
Poland	-93,916	46,500	0.948	-9,668	4,800	0.866
Czechia	-21,556	-1,000	0.132	-1,200	666.7	0.991
Lithuania	-1,010	500	0.941	-505	366.7	0.993
Italy	-3,017	2,500	0.988	-704	500	0.993
Spain	-2,488	2,500	0.989	-602	433.3	0.993
Romania	-1,987	1,666.7	0.964	-401	333.3	0.993
Norway	-503	666.7	0.989	-200	200	0.995

Source: compiled by the author

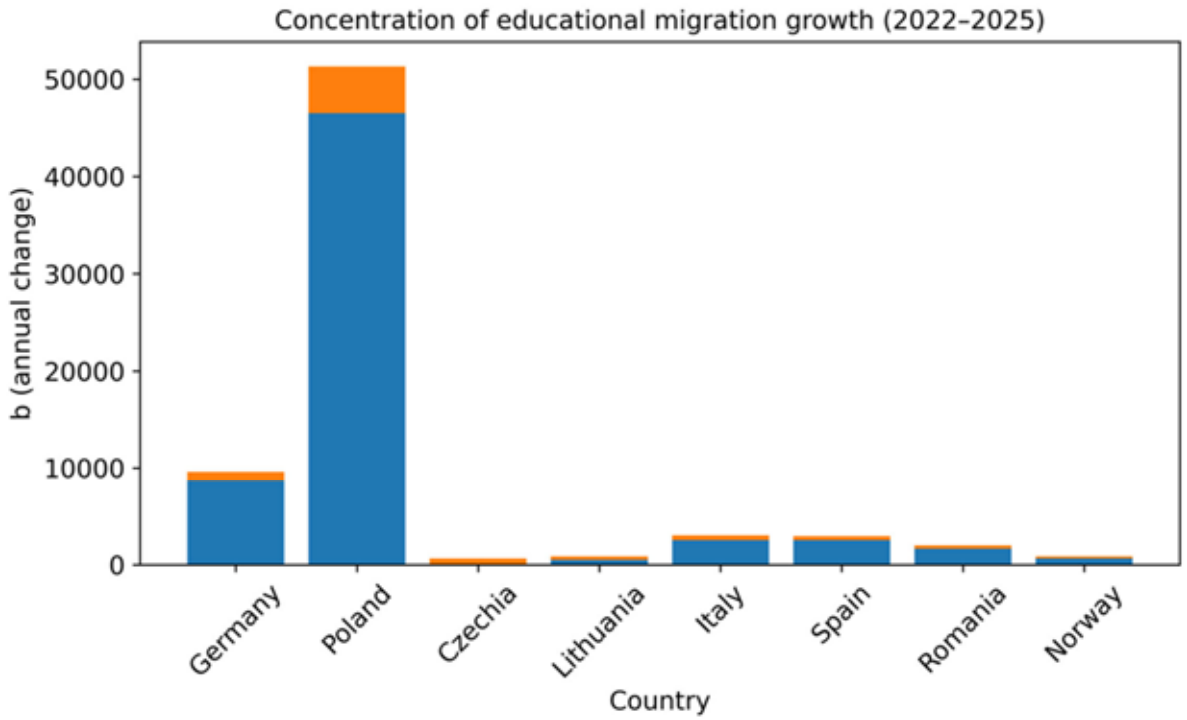


Figure 5. Comparison of trend coefficients (b) for Ukrainian schoolchildren and university students across destination countries, 2022-2025

Source: formed by the authors based on [16-22]

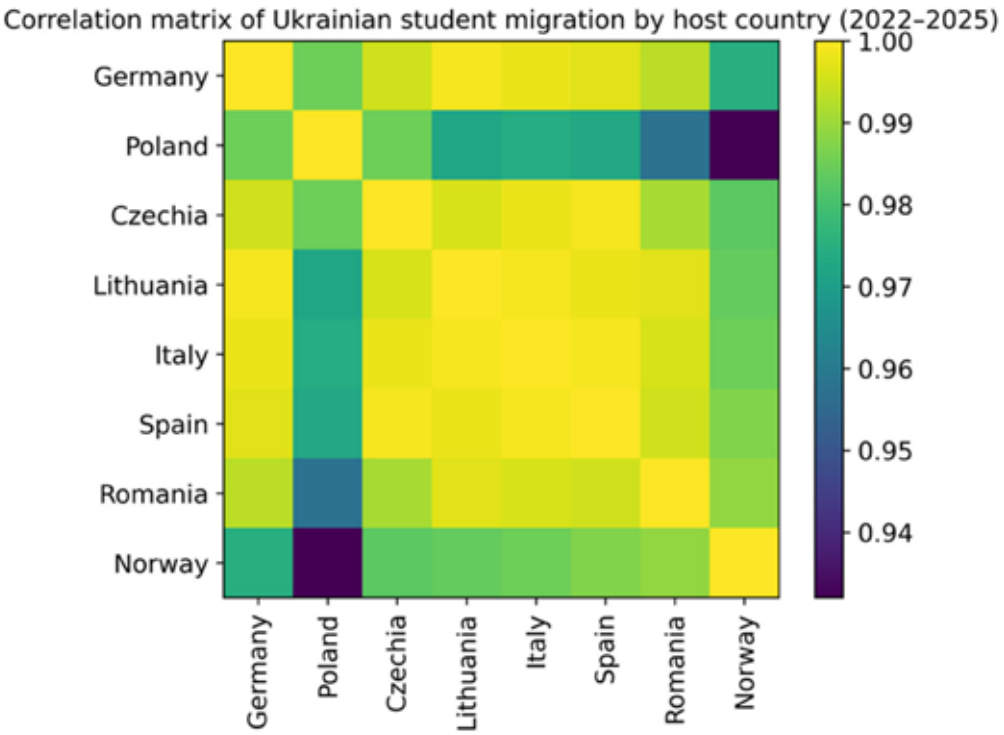


Figure 6. Correlation matrix of Ukrainian educational migration indicators in selected European countries (2022-2025)

Source: formed by the authors based on [16-22]

reflects not only the forced nature of migration caused by military events, but also the gradual formation of a new structure of academic mobility within the European educational space. From the perspective of educational policy, the results of the study indicate the need for further development of mechanisms supporting the academic mobility of Ukrainian students and schoolchildren. In particular, an important direction is the expansion of academic exchange programs, the development of joint educational programs between Ukrainian and European universities, as well as the creation of conditions for the return of Ukrainian students and researchers after completing their studies.

In the long term, educational migration may become an important factor in the formation of a transnational educational space between Ukraine and the countries of the European Union. Effective management of this process requires coordination of educational policies at both national and international levels, as well as the development of strategies aimed at preserving and developing Ukraine's human capital. To test the robustness of the model, a multicollinearity diagnostic was conducted using the Variance Inflation Factor (VIF)**.** The obtained VIF values for the independent variables are significantly below the threshold value of 5, indicating the absence of substantial multicollinearity and confirming the reliability of the estimated coefficients.

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