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Peculiarities of the impact of learning losses on the formation of human capital in Ukraine under martial law

Abstract. During the period of the pandemic and martial law, Ukraine has lost a significant part of its human capital: assessing these losses and developing proposals for their restoration is especially relevant in the context of the need to restore Ukraine's economy in the post-war period. The purpose of the article was to study and systematize the causes of human capital losses and their structure, to determine the impact of learning losses on the formation of human capital, as well as to summarize proposals for compensation for learning losses and restoration of human capital. As a result of the analysis of the scientific works, a number of factors have been identified that affect the level of learning losses and learning gaps due to quarantine restrictions in various countries of the world, namely, Germany, Spain, Belgium, China. The systematization of information made it possible to group the factors that affect learning losses in Ukraine, with the allocation of groups of factors that are due to the restriction of opportunities to attend educational institutions, and groups of factors that have arisen as a result of hostilities in Ukraine. The paper substantiates the existence of regional differences in the occurrence of learning losses and their impact on the formation of human capital. The clustering of regions has been carried out on the basis of losses of entrants in educational institutions and the region's contribution to the creation of the gross domestic product of Ukraine. The results of the clustering made it possible to determine the priority directions for the restoration of human capital. Based on the research results, measures to eliminate learning losses and learning gaps for educational institutions of various levels are proposed, which can be applied in practice in the post-war reconstruction of the country's economy

Keywords: economic development; educational institutions; gross domestic product; human capital index; productivity of the next generations; quality

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INTRODUCTION

Human capital is one of the key factors in the development of the country's economy, it determines its potential, competitiveness, and ensures the formation of national income. The pace of economic development, the scope of innovation and innovative solutions in various socio-economic spheres of the country, the level of social development are determined by the quality of human capital. The deterioration of the educational component of human capital formation as a result of the restrictions caused by the COVID-19 pandemic in Ukraine has intensified due to hostilities. Active military actions on the territory of Ukraine have had a negative impact on the country's economy, on all its basic components. The problems of the formation of high-quality human capital for the post-war recovery of Ukraine are becoming especially urgent.

As of 2024, learning losses and learning gaps in Ukraine are part of a broader economic problem – significant losses of human capital. This is a real problem of the post-war recovery of Ukraine's economy, since the number of "carriers" of human capital – the number of working-age population and the population of Ukraine as a whole – is significantly decreasing. The question of human capital and its influence on the development of countries is discussed on the sidelines of the World Economic Forum (2017) summit. It is human capital that acts as one of the driving forces of economic development and forms the potential for the prosperity of society. In the report of the Ukrainian Institute for the Future, human capital is defined as the totality of everything on which labour productivity depends in combination with its contribution to achieving the development of all spheres of social and economic life (The importance of human capital…, 2021). That is, human capital is one of the active factors that contributes to the development of society and acts as a potential for such development. Summarizing the results of research by Z. Liu *et al.* (2024) on human capital structure and K.G. Abraham & J. Mallatt (2022) regarding its main components, the following elements can be distinguished: abilities, education, skills, motivation. The specified constituent elements are basic, which largely determine human capital. Among other constituent components, scientists distinguish: qualification, which is highlighted by Y. Honjo (2021), health, experience, self-organization, self-improvement, as noted by M. Wang *et al.* (2021), psychological characteristics, talent, development of non-standard thinking and cultural development.

One of the criteria for measuring the level of human capital development is the determination of the human capital index for the countries of the world. At the initiative of the World Bank, the global Human capital project was introduced (n.d.). The project was introduced under the auspices of actualizing the problems of inequality in the world, focusing attention on the need to invest in human capital as the main driver of socio-economic development and highlighting the most effective directions of such investment. The calculation of the human capital index is an integral indicator that allows comparing different countries of the world with each other in terms of individual elements and the overall level of development. Also, this index serves as a kind of indicator to determine the standard of living in a certain country of the world. The human capital index makes it possible to determine not only the current standard of living, but also is aimed at forecasting the future indicators of such a specific asset as human capital, as it is a kind of assessment of the productivity of the next generations. According to the calculation methodology of the World Bank (2020), the human capital index can indirectly characterize the forecast indicators of profitability both for a specific person and for the country as a whole. The effectiveness of attracting such human capital relative to a possible reference value is determined through the result, namely the profitability and efficiency of the production process, through the potential volume of gross domestic product (GDP).

The main components of human capital are characterized by three groups of indicators. The first group is demographic, including birth rate, death rate, migration processes, etc. The second group is educational, namely, the quality of the education received and the provision of population with different levels of education. The third is health, due to the quality of the environment, life expectancy, availability of health care services. In this triad, it is the quality of education that becomes an important component of the formation of human capital due to its direct connection with obtaining economic results in the future. The first global study of the level of development of the countries through the index of human capital covered 130 countries and was conducted by the World Bank with the publication of the corresponding report (Human capital project, n.d.). The results of the research in the context of different countries highlighted the deep crisis of human capital on a global scale due to underestimation of the role of human capital in the modern world and its impact on economic development, underfunding of certain sectors of the economy, insufficient investment in human capital, etc. According to World Bank (2020) forecasts, such a poor state of human capital will have a negative impact on future economic development, which requires immediate reaction.

Taking into account the world trends, the study of issues related to the restoration of human capital is extremely relevant both at the global level and for ensuring Ukraine's development potential. The purpose of the work was to analyse learning losses that occurred as a result of restrictive measures during the COVID-19 pandemic and military aggression, and to determine the main directions for overcoming such losses at different levels of education in Ukraine.

MATERIALS AND METHODS

The research was accompanied by the use of a wide range of scientific research tools. The use of tabular and graphical methods provided a visual representation and visualization of the obtained results. The paper uses the methods of statistical research, namely, the method of mass observations and the method of groupings are used to identify and systematize the factors that influenced the organization of the educational process of schools, as well as higher education institutions (HEIs) and professional pre-higher education institutions (PPHEIs). The occurrence of learning losses and learning gaps is due to the presence of various prerequisites, including the peculiarities of the organization of the educational process, technical equipment,

resource availability, and other factors that affect the quality of training, so the analysis made it possible to identify regional features, as well as differences inherent in different levels of education.

Statistical observation tools were used to analyse demographic indicators and identify trends in quantitative estimates of the population. The country's population acts as a carrier of human capital. Therefore, the analysis of the dynamics of the country's population, trends of change, identification of factors influencing the dynamics of indicators and determination of the degree of their influence, with the help of statistical observation, occupies an important place in the study of processes that form human capital in the context of the country's post-war recovery. On the basis of this, the impact of irreversible losses of current human capital as a result of forced migration processes on the educational component of human capital formation and on quantitative indicators of human capital has been determined. An analysis of the theoretical basis of the categories of human capital and its main indicators, namely, the human capital index, learning losses and learning gaps using the method of analysis, is also carried out.

The analysis of scientific developments of Ukrainian and foreign authors was used in the study of simulation models on the impact of migration processes on human capital and the country's development potential. Military operations on the territory of Ukraine, different degrees of active involvement of each of the regions and proximity to the zone of active hostilities, have led to objectively different conditions that have developed in different regions, therefore, with the help of the index method, the loss coefficient of entrants to HEIs and PPHEIs for each of the regions of Ukraine has been determined, followed by the ranking of regions by the level of losses of entrants and the correlation of the regional level with the average value of Ukraine. Thanks to this, it was possible to determine the effect of the loss of entrants to educational institutions that provide training at a high level.

The use of the clustering method made it possible to group regions taking into account learning losses and the contribution of the region to the creation of GDP. The results of the clustering became the basis for identifying regions that need special support for the preservation and development of educational potential, support for educational institutions of certain regions, taking into account their contribution to the formation of national income and high-quality human capital. The results of clustering are the basis for determining the directions for the formation of human capital in the context of Ukraine's recovery.

RESULTS AND DISCUSSION

The essence and peculiarities of human capital formation

In its essence, human capital is an economic value for the country. The quality of human capital becomes the key to the country's development and its positioning in the world economic space. In their research, V. Antonyuk (2022) determines that human capital is a key resource for the production of economic goods and the formation of the country's national income. It is the productive abilities of a person formed through a combination of knowledge, skills and experience, that become the basis of the quality of human capital. In their studies V. Rodchenko *et al.* (2021), as well as M.T. Ballestar *et al.* (2020) share the similar point of view that it is the quality of human capital that becomes a determining factor in the economic growth of the economy. In turn, the authors single out labour productivity among the indicators of the quality of human capital. According to estimates of the World Bank (2020) in the pre-war period of 2020 in Ukraine, human capital accounts for only 30% of national wealth. On the other hand, for developed countries, this indicator reaches 70%, including Austria – 75%, Denmark – 76%, Italy – 73% (Gresham & Ambasz, 2019). The ultra-low level of Ukraine's indicators requires identifying and eliminating the reasons for this result. The work of G. Nazarova & V. Rudenko (2022) focuses on the fact that the formation of human capital, the impact on its qualitative characteristics, and continuous improvement should be systemic. Investing in all components of human capital contributes to the growth of the national economy (Dziamulych & Grudzevych, 2020). The active involvement of the education system at all its levels, the involvement of subjects of economic relations, institutions in the creation of a "smart society", should increase the quality of human capital of modern society.

Military operations are causing destruction in the country, there is a significant decline in the economy, the destruction of infrastructure, and the disruption of established socio-economic ties. In the conditions of military operations, human capital suffers significant losses in all its components both at the current moment, due to a significant reduction and structural changes of the available human capital, and in the future. Losses that arise at different stages of human capital formation have a long-term negative impact on its quality and on the prospects for the country's development. As mentioned, among the factors that influence the formation of human capital, there is a group of indicators that describe demographic processes in the country. Figure 1 shows the demographic indicators of Ukraine in the period from 1991 to 2022 in terms of the dynamics of births, deaths and population size.

The main indicator of the natural movement of the population is the difference between the birth rate and the death rate, which can be positive (growth) or negative (depopulation). In the period from 2014 to 2022, the birth rate decreased more than twice, while the number of deaths increased from 632.3 thousand people to 714.3 thousand people in 2021. The intensification of hostilities on the territory of Ukraine causes an even greater increase in the death rate in 2022-2023. According to statistical data (Fig. 1), it is necessary to state that since 1994 there has been a steady downward trend in the population. A significant reduction occurred in 2014 and during 2022. As of 2023, according to the UN Population Fund, the population of Ukraine is 36.7 million people (World Population Dashboard. Ukraine, 2023). Indicators of natural migration increase significantly as a result of the influence of the forced migration factor. Waging active hostilities on the territory of Ukraine is reflected in a significant reduction of the population. However, the information cannot be statistically significant without the presence of other indicators, that is why the dynamics are considered for 2022 inclusive. The negative trends in the demographic component of human capital are exacerbated by the fact that a large number of

people became refugees during the hostilities. According to the Operational Data Portal on the Ukraine refugee situation (2023), as of June 6, 2023, 6,280,000 refugees were recorded worldwide, of which 5,935,300 were in Europe and 344,700 people outside Europe. These are official data that do not cover all people who were forced to leave Ukraine.

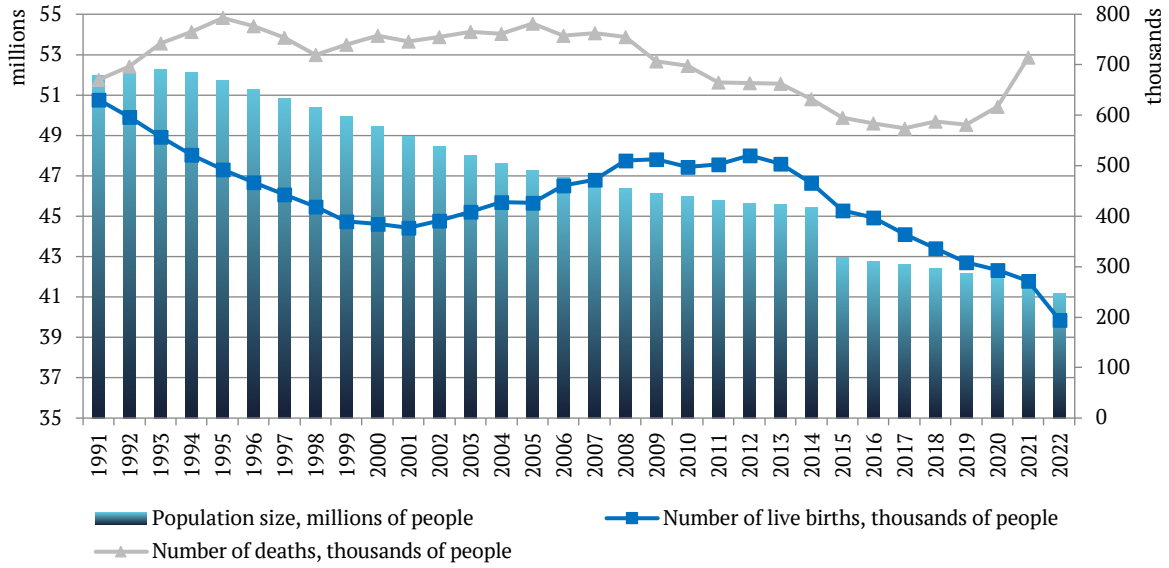

Figure 1. Dynamics of Ukraine's population and the number of births and deaths
Source: compiled by authors based on Live births and deaths by region (n.d.)

However, even these data show the impressive size of the demographic crisis, which will be fully manifested after the end of hostilities. Not all refugees will return to Ukraine, as some of them found work during the period of hostilities, and their children began to study at schools and universities. As a result of hostilities in Ukraine, military and civilians are killed and seriously wounded, the vast majority of whom would be active participants in the reconstruction of Ukraine. Such losses also have a significant negative impact on human capital.

In their work, P. Ueffing *et al.* (2023) modelled four research "what-if" scenarios that combined assumptions about the scale of war-induced refugee movements, return migration in the context of future recovery, reconstruction, and a set of long-term migration trends. The proposed scenarios try to cover a wide but realistic range of possible future development options, from the pessimistic scenario of a long war, protracted conflict and slow post-war economic recovery to the optimistic scenario of a short war and rapid post-war recovery, ensuring long-term social and political stability and economic growth. However, in all scenarios, it has been proven that migration is as important a factor as mortality and birth rates for the long-term future of Ukraine's population.

The authors believe that long-term population decline over the coming decades seems irreversible, even if Ukraine recovers quickly from the short war and becomes a host country for international migrants. This is accompanied by the problem of a rapidly aging population and a shrinking workforce. Reconstruction efforts, long-term recovery support, and socio-economic and political developments in the context of possible EU accession will affect return migration and future migration patterns, which could result in the country losing a quarter to a third of its population by mid-century. The projected volume of population decline in Ukraine will have a significant impact on the quality of human capital.

Assessment of human capital is carried out through a set of quantitative and qualitative characteristics that describe its components. In addition to indicators that determine the demographic aspect, namely, indicators of population size, its dynamics, migration processes, an important role in the formation of human capital belongs to the educational component, namely, the level of education development, the quality of education, science, the share of expenditures on scientific developments in the structure of the country's GDP, etc. Education, its quality, the level of population coverage is the dominant factor in the formation of human capital and its quality.

Active hostilities in the country affect the educational component of the formation of human capital both through the destruction of the educational infrastructure and the material base, and through the limitation of opportunities for a full-fledged educational process, obtaining relevant knowledge, and acquiring competencies. All this leads to the emergence of the concept of learning losses. Thus, it is necessary to investigate learning losses and propose ways to eliminate them in the context of the need to preserve and restore the human capital of Ukraine.

The global scientific community began to take intensive care of the problems of learning losses and learning gaps with the onset of the COVID-19 pandemic. Different interpretations of the "learning losses" and "learning gaps" concepts are used in literature. The legislation of European countries, in particular of Ukraine, does not contain the specified definitions, but the relevant concepts are usually used in analytical materials, monitoring studies, reports, scientific articles presented at the level of academic

developments or the results of the activities of international organizations in the field of education quality assessment (Hearings in the committee ..., 2023).

The most acceptable are the definitions given in The Glossary of Education Reform: learning loss is understood as any specific or general loss of knowledge and skills or regression in education, most often due to long gaps or interruptions in education. Achievement gap refers to outputs – unequal or unfair distribution of educational results and benefits (Achievement gap, 2013). It should be clarified that the specified gaps occur when students have unequal access to educational processes. Inequality can be caused by a combination of social, economic and other factors.

Differences in access to quality education in different population groups have always existed. Educational inequalities have been significantly exacerbated and manifested as a result of school closures due to the COVID-19 pandemic. Martial law in Ukraine, as well as active hostilities in some regions, only exacerbate the problems of inequality in the educational process and knowledge acquisition. The emergence of restrictions on attendance at educational institutions, namely, schools, colleges, universities, as a result of quarantine or martial law, leads to significant differences in the learning outcomes of students. Firstly, these are differences in results among students within a certain group, they are due to a number of factors. Secondly, these are differences in comparison with a similar group of students who receive education without these restrictions.

Among the factors that influence the occurrence and size of learning losses, the following are identified. The first is a group of factors of a personal nature, which is determined by the totality of personal traits of students, their individual characteristics. The effectiveness of assimilating certain knowledge, acquiring skills, competences while working in groups, during face-to-face contact, as well as during individual work remotely or independently is different for each person. The level of perception of information obtained by different forms of organization of the educational process and for different age groups has significant differences. Ability to self-organization, self-discipline, etc.

The second group of factors is determined by the characteristics of the students' family. The level of education of parents and their motivation to provide a certain level of quality education to children, as well as the financial capabilities of parents to provide the technical support for the implementation of the educational process using means of communication, software, etc. are very much important. However, the remote access cannot fully replace the capabilities of educational and scientific centres and the implementation of the educational process directly using advanced equipment. A significant weakening of the practical component of the educational process is also reflected in learning outcomes as learning losses, which in the future will have to be compensated through additional training to ensure the full performance in this or that job in the real sector of economy.

This, in turn, is additional expenditure of resources and lack of income. The third group of factors generally includes infrastructural ones. These include the availability of the Internet and its capacity, the availability of means of communication and the effective system that makes it possible to carry out an effective educational process in various forms. The impact on the mentioned factors can only level the volume of losses as a result of the disruption of the educational process.

The moment at which learning losses occur, that is, at what level of education there is a shortage of learning outcomes, directly affects the amount of additional resources that need to be spent to compensate for such losses, as well as the amount of lost income in the future. Failure to obtain a certain set of knowledge affects the quality of human capital that is being formed at the current time, and will have a long-term negative economic effect in the future, due to the lack of economic benefits from such human capital during its active activity in the creation of national income, as well as due to the need for additional costs of financial, time and other types of resources for their additional training.

The obtained results are confirmed by studies that were conducted in various countries following the closure of educational institutions due to quarantine restrictions. A study by S. Zinn & M. Bayer (2021) conducted in Germany shows that parents with a low level of education and socio-economic status could not provide their children with the necessary level of educational activity.

Similar results were obtained by X. Bonal & S. González (2020) based on the study of learning outcomes in Spanish schools, confirming impact of the role of the family, their material wealth, and cultural level on learning outcomes. This paper and S. González & X. Bonal (2021) argue that middle-class families were able to maintain higher standards of educational quality in a critical context, while children from socially disadvantaged families had few opportunities for learning both in terms of time and learning experience (school work and provision of extracurricular activities). Missed opportunities to visit institutions for schoolchildren from socially disadvantaged families affect the deterioration of learning outcomes, the lack of a certain set of skills, competencies at the current point in time. In the case of continuing education at the next levels without making additional expenditure of resources to compensate for previous learning losses, the learning outcomes of such graduates will be much worse, which ultimately affects the quality of human capital formation.

In their article, N. Duroisin *et al.* (2021) presented the results of a study on the impact of the pandemic on the quality of education in Belgium. Learning losses caused by quarantine restrictions have an impact on learning outcomes and, accordingly, on the quality of human capital being formed. The authors also emphasize the great role of technological equipment and advanced pedagogical practices and the access of pupils and students to them. Of course, ultimately, access to advanced technologies is ensured by the level of family income.

Similar conclusions were made by H. Liao *et al.* (2022) in their work based on the results of a study of the academic performance of students in the Chinese province Shaanxi with different socio-economic statuses of parents during the pandemic. They demonstrate that students with more educated parents performed better in relative test scores after full-time education resumed. It is claimed that this is due to the involvement of parents in homeschooling their children. Ultimately, such graduates ensure the formation of human capital of higher quality compared to their peers.

Thus, research into the causes of learning gaps among schoolchildren as a result of the pandemic in Germany, Spain, Belgium and the China showed their significant dependence on the material wealth of families and the level of education of parents. It can be stated that the additional costs of compensating for learning losses that arise actually fall on parents. Otherwise, there is a growing gap in the level of education of different segments of population. The increase in the share of the population with a low level of education affects the quality of human capital that is formed today and a decrease of potential income from such human capital in the future.

Learning losses as a result of military operations

In Ukraine, the problems of the pandemic have entered a new dimension, which is caused by military aggression. The impact of hostilities on educational processes in Ukraine, in addition to the negative consequences that were inherent during the pandemic, is significantly exacerbated by a considerable number of various additional factors. Included are psychological, regional and irresistible factors due to destruction and air alarms. Thus, such conditions could not help but affect learning outcomes at all levels of education, which directly affects the quality of human capital.

In many regions, infrastructure was damaged, in particular, there was partial or complete destruction of educational institutions. The hostilities have led to the destruction of housing, which, together with threats to life, have forced millions of people to migrate abroad or become internally displaced persons. Economic restrictions have worsened, so many families are unable to pay for their children's education and continue their own education.

Air raids and military operations do not make it possible to carry out a full-fledged educational process at all levels of education and transfer it to a distance form. The war leads to an aggravation of neuropsychological problems, including an increase in psychological stress among children, young people and their parents. This has a direct impact on their ability to learn and their parents' provision of learning environments. Internal displacement and migration did not bypass teachers and other educators, which only exacerbated problems.

Subjects of the educational process, both pedagogical workers, scientific-pedagogical workers, and students and their parents, to various degrees change the priorities that require an urgent solution. This is due to the factors that ensure the conditions of own safety, with the need to adapt to a new place of residence through the minimization of linguistic, cultural and other barriers, the availability of necessary conditions to continue educational process. There is a high dependence of the learning outcomes of primary and secondary school children on the teaching skills of their parents, and not only on the availability of means of communication. Emotional perception of the learning process, formed at a young age, will have a delayed effect on the effectiveness of further learning throughout life.

All this has led to the limitation of access to quality education in high school, vocational and technical institutions, pre-higher and higher education and caused significant learning gaps in different categories of citizens, depending on their economic and organizational capabilities. Children from low-income families, refugees, internally displaced persons and other vulnerable groups are particularly affected by limited access to education.

In December 2022 – January 2023, as part of the implementation of the SURGe (Support for Government Reforms in Ukraine) project, a study of learning losses at the school level (One third of students…, 2023) was conducted. The results of the study made it possible to identify the following factors. Lack of access to the educational process: more than 30% of schoolchildren did not have permanent access. Migration processes had a significant impact on the contingent of schoolchildren and the contingent of teaching staff. The relocation of schoolchildren and teachers mainly from the eastern and northern regions to safer places covered more than 20%. Violations of stable social groups and social ties have a negative psychological impact on the participants of the educational process. Not the last place is occupied by the problems of technical equipment of teachers and students. The vast majority of schoolchildren, almost 74%, use smartphones for studying, due to the lack of laptops or computers. The provision of teachers with working access to the Internet and computers remains unsatisfactory. Almost 20% remain unsecured.

Thus, in Ukraine, the factors that cause learning losses and learning gaps among schoolchildren are much stronger than in the countries discussed above. These were compounded by the destruction of educational infrastructure, air raids, lack of electricity, lack of Internet, and the displacement of students and teachers, both within the country and abroad. These factors increased the dependence of the size of learning losses and learning gaps on the material wealth of families and the level of education of parents. Moreover, it can be assumed that they also depend on the psychological stability of parents and their motivation to raise and educate their children.

This combination of factors has a negative impact on the organization of the educational process and its result, creating the prerequisites for the formation of human capital of inadequate quality. Children who had limited access to education from the eighth to the eleventh grade leave school into adulthood. Only a small number of them have mastered the necessary amount of knowledge, skills and abilities to continue their studies in HEIs or PPHEIs. This was achieved due to the high motivation of both children and their parents. Moreover, such preparation had to be based on the powerful economic and organizational capabilities of families and the child's cognitive abilities.

These characteristics influenced not only school education, but also the educational process in Ukrainian HEIs. However, this impact is not catastrophic. In the world, there are examples of the development of education at all levels, including higher education, during the period of military operations. In the article by S. Milton (2019), it is argued that Syrian higher education continues to function despite the long-term war raging in the country. Based on interviews with Syrian students and academics, it was found that while the system has survived quantitatively, it has suffered significant qualitative losses in learning outcomes. However, it is not about the collapse of the system, as is sometimes portrayed in the media. Instead, it is about the need to support Syrian refugees in obtaining secondary education with the prospect of their return to the country

to obtain higher education. Such an approach can be an example for Ukraine when it comes to the need to preserve and increase human capital.

In Ukraine, it is not about a catastrophic situation in higher education. Apart from the indicators of the impact on learning losses and gaps, which have been identified in general for all levels of education, the following is characteristic of higher education. A significant number of armed forces, mainly from the regions of active hostilities, suffered destruction of the material and technical base.

The level of education of entrants has significantly decreased, not all HEIs were ready for distance learning. The effectiveness of scientists' work has decreased significantly, not only as a result of the loss of the material base, but also due to an unstable psychological state. Professional relations with enterprises, organizations and business as a whole have significantly weakened. This applies not only to the field of scientific and project development, but also to the provision of practice bases for course and diploma design. The practical component of the educational process in HEIs has weakened to a large extent due to the lack of opportunities to conduct laboratory work.

In HEIs located in the most dangerous territories, the implementation of a number of projects with external stakeholders, which were aimed at improving the quality of education (dual education, implementation of joint projects with foreign partners, as part of their implementation on the territory of Ukraine), was interrupted. As a result of the psychological stress of higher education students, their ability to study decreases and the level of emotional intelligence suffers. There is a strong differentiation in the size of the contingent of higher education seekers, depending on the distance from the combat zone. The determining factor for those seeking education when choosing a HEI for study is not the quality of training, not the rating indicators of the HEI, or the preference for one or another HEI, but the territorial distance from the zone of active hostilities.

HEIs from the regions close to the places of hostilities lose not only the contingent, but also the income from the special fund. These HEIs are forced to significantly reduce the cost of educational services, as there is a decrease in business activity in these regions. That is why HEIs from these regions need financial support through the general fund. A significant decline in business activity, according to the European Business Association, which is observed in the eastern regions of the country, affects the solvency of the region's population, reducing the ability to plan their own expenses for 4-6 years (Reservation, mobilization..., 2023). The lack of stable income, a high level of risk lead to the fact that entrants choose not those specialties for which they have abilities and talent, but those where they can enter to study under the state order, even if after graduation they plan to work not in their specialty. On the one hand, this significantly affects the formation of human capital, has a negative impact on its quality, and on the other hand, it exacerbates the problem of irrational use of budget funds. There is a significant change in the scale of priorities for choosing a specialty and an educational institution. The "safety" factor comes first for entrants and their parents. Even the entrant's choice regarding HEI can be adjusted by parents in order to reduce the levels of risks and safety of children.

It should be noted that there are significant regional differences in the functioning of educational institutions. HEIs that are or were in the zone of active or potentially active hostilities will have a significantly underestimated number of people wishing to receive education in these regions, even with high ratings, high quality of training, high-quality staffing, etc. At the same time, HEIs located in other territories will have a relatively increased number of potential entrants and students. The calculation of the loss coefficient of entrants in 2022, which was a consequence of the start of active hostilities on the territory of Ukraine, was carried out by comparing the data of 2021 and the first intake after the start of hostilities. The calculation of the loss coefficient of entrants clearly reflects this in the context of the regions of Ukraine (Fig. 2).

The loss coefficient of entrants is estimated as the ratio of the delta of the number of applications in 2022 and the number of applications in 2021 to the number of applications submitted in the pre-war 2021. A negative value of this ratio indicates the level of losses, i.e. a drop in the number of those wishing to obtain education at the appropriate level, higher or professional pre-higher education in a certain region (the calculation was made based on the number of applications for the "Bachelor" degree on the basis of complete secondary education and "Professional Junior Bachelor" degree). The number of applications submitted by entrants is an estimated value and a certain indicator of the distribution of entrants' wishes regarding further education. The situation in 2023 does not compensate for the losses that occurred in 2022. The year 2022 is an indicator of "failure" and reflects the impact of the start of hostilities.

In general, according to USEDE (2023) data (Unified State Electronic Database on Education), there was a drop in the number of people wishing to study in educational institutions of Ukraine. The loss coefficient of entrants to HEIs is −0.437 (Fig. 2), and the loss coefficient of entrants to PPHEIs is −0.36. The largest decrease is observed in Kharkiv (−0.66 of HEIs losses and −0.51 of PPHEIs losses), Mykolaiv (−0.55 of HEIs losses and −0.46 of PPHEIs losses) and Zaporizhzhia (−0.49 of HEIs losses and −0.49 of PPHEIs losses) regions. These are the areas that are the most dangerous and closest to the war zone.

According to Resolution of the Cabinet of Ministers of Ukraine No. 179 "On Approval of the National Economic Strategy for the Period up to 2030" (2021), the specified areas are assigned to the 1st group, namely the territories where hostilities are (or were) taking place. In some regions (Odesa, Zhytomyr, and Kyiv), the level of the loss coefficient does not significantly differ from the national average. In all other areas, there is either a slight decrease in potential entrants or even an increase (the coefficient is greater than 0).

A visual representation of the distribution of the loss coefficient of entrants by region confirms the internal movement of potential education seekers and the priority of their choice in favour of security and safe territories. E. Hanushek & L. Woessman (2020) studied the economic consequences of learning losses in the long term. The authors provide calculations of projected long-term GDP losses for G20 countries that were caused by pandemic learning constraints and estimate expected GDP over 50 years.

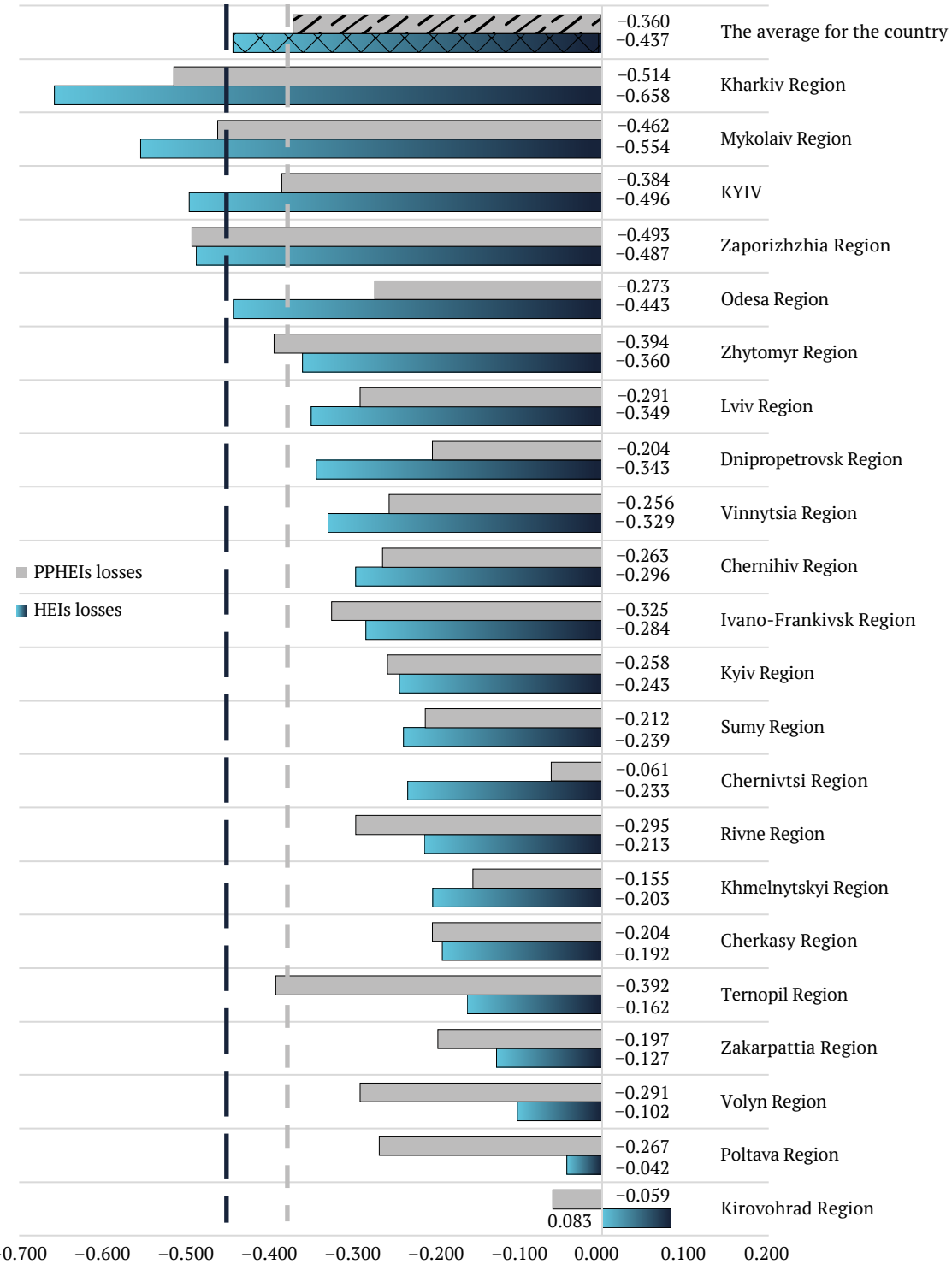

Figure 2. Regional distribution of the loss coefficient of entrants to HEIs and PPHEIs in 2022 in relation to 2021
Source: made by authors based on USEDE (2023)

The quality of education, the level of education in society correlate not only with a person's personal income, but they are also projected on the dynamics of the well-being of society, the country, and the dynamics of the main macroeconomic indicators. Entering the labour market of human resources with a lower level of education leads to a comparatively lower level of productivity and profitability of such labour. Within the country's economy, the gradual replacement of workers who leave active labour relations by graduates of educational institutions of various levels who lacked certain skills, will affect the long-term dynamics of the country's GDP during the period of work of workers with learning losses until their retirement. In the knowledge economy, the influence of human capital on the creation of GDP significantly increases.

Regional peculiarities of human capital formation

It should be noted that there is a close connection between human capital and the country's GDP. Learning losses in Ukraine, which significantly worsen human capital, will also have an impact on the creation of GDP, as one of the main indicators of economic development. Analysis of information data for 2021 showed uneven contribution of each region of Ukraine to GDP (Gross regional product, n.d.). The results of the analysis are correlated with the data of the Public report State Tax Service of Ukraine 2022 (2023) regarding the regional distribution of the main taxpayers who are registered with the territorial body of the State Tax Service. The list of regions of Ukraine that fall into each of the quadrants in the following matrix of the distribution of regions of Ukraine, as well as the calculated values of the indicators are given in Table 1.

Table 1. Distribution of Ukraine's regions in quadrants by contribution to GDP and loss coefficient of entrants

No.	Region	Loss coefficient of entrants		GDP, billion UAH	Quadrant	
		HEIs	PPHEIs		HEIs	PPHEIs
1	Kharkiv Region	−0.658	−0.514	320	1	1
2	KYIV	−0.496	−0.384	1,196	1	1
3	Zaporizhzhia Region	−0.487	−0.493	229	1	1
4	Odesa Region	−0.443	−0.273	272	1	2
5	Dnipropetrovsk Region	−0.343	−0.204	582	2	2
6	Lviv Region	−0.349	−0.291	296	2	2
7	Kyiv Region	−0.243	−0.258	292	2	2
8	Poltava Region	−0.042	−0.267	267	2	2
9	Vinnytsia Region	−0.329	−0.256	174	3	3
10	Cherkasy Region	−0.192	−0.204	131	3	3
11	Khmelnytskyi Region	−0.203	−0.155	120	3	3
12	Ivano-Frankivsk Region	−0.284	−0.325	120	3	3
13	Chernihiv Region	−0.296	−0.263	113	3	3
14	Sumy Region	−0.239	−0.212	105	3	3
15	Kirovohrad Region	0.083	−0.059	100	3	3
16	Volynsk Region	−0.102	−0.291	93	3	3
17	Rivne Region	−0.213	−0.296	89	3	3
18	Zakarpattia Region	−0.127	−0.197	76	3	3
19	Chernivtsi Region	−0.233	−0.061	55	3	3
20	Ternopil Region	−0.162	−0.392	81	3	4
21	Zhytomyr Region	−0.360	−0.394	114	3	4
22	Mykolaiv Region	−0.554	−0.462	124	4	4
	The average for the country	**−0.437**	**−0.360**	**218**		

Source: developed by authors based on USEDE (2023) and Gross regional product (n.d.)

Figures 3-4 show the distribution matrix of Ukraine's regions by indicators: gross regional product, as an indicator of the share of each region's contribution to the creation of GDP, billion UAH, vertical axis; loss coefficient of entrants by the relevant level of education (bachelor, professional junior bachelor) by region horizontal axis. The point of intersection of the axes corresponds to the national average. The given matrix of regional distribution consists of four clusters (quadrants).

Quadrant I: regions whose educational institutions need special support. Significant losses of entrants, the loss coefficient of entrants is much worse than the average for Ukraine, and the contribution to the country's GDP of each of these regions exceeds the average for Ukraine. Quadrant I includes Kharkiv, Zaporizhzhia Regions and the Kyiv city. Odesa Region is included in the first quadrant in terms of losses in HEIs. Learning losses in the regions of the Quadrant I have the most significant impact on human capital, on the country's economy, its recovery and development potential. In these regions, the activities of business entities and the relevant infrastructure are concentrated ensuring the creation of the country's GDP. According to 2021 data, the regions of the Quadrant I account for almost 37% of the GDP of Ukraine (Gross regional product, n.d.) and 37% of the main taxpayers (Public report..., 2023). The capital occupies a special place. The largest contribution to the creation of GDP falls on the Kyiv, since the legal addresses of the main representative offices are registered in the city of Kyiv, regardless of the actual territorial location of production facilities. The negative impact of the high level of loss of entrants is aggravated by the factor of the territorial location of these regions. The territorial proximity of the region to the zone of active hostilities is reflected in the financial and economic activity of the region, the activity of business in this region, and the change in priorities of financial investments.

Quadrant II: regions whose educational institutions need support. Insignificant loss of graduates, the rate of loss of entrants is better than the average for Ukraine; and the contribution to the country's GDP of each of these regions exceeds the average indicator for Ukraine. Quadrant II includes: Odesa Region only by PPHEIs losses, as well as Dnipropetrovsk, Kyiv, Lviv, and Poltava Regions. Despite the fact that the level of learning losses in the regions of

the Quadrant II is insignificant, these losses will also have a significant impact on the dynamics of GDP generated in these regions. The contribution of the four regions of the Quadrant II to the creation of GDP is more than 26%. And 22% of the main taxpayers are registered with the territorial bodies of the State Tax Service of these regions.

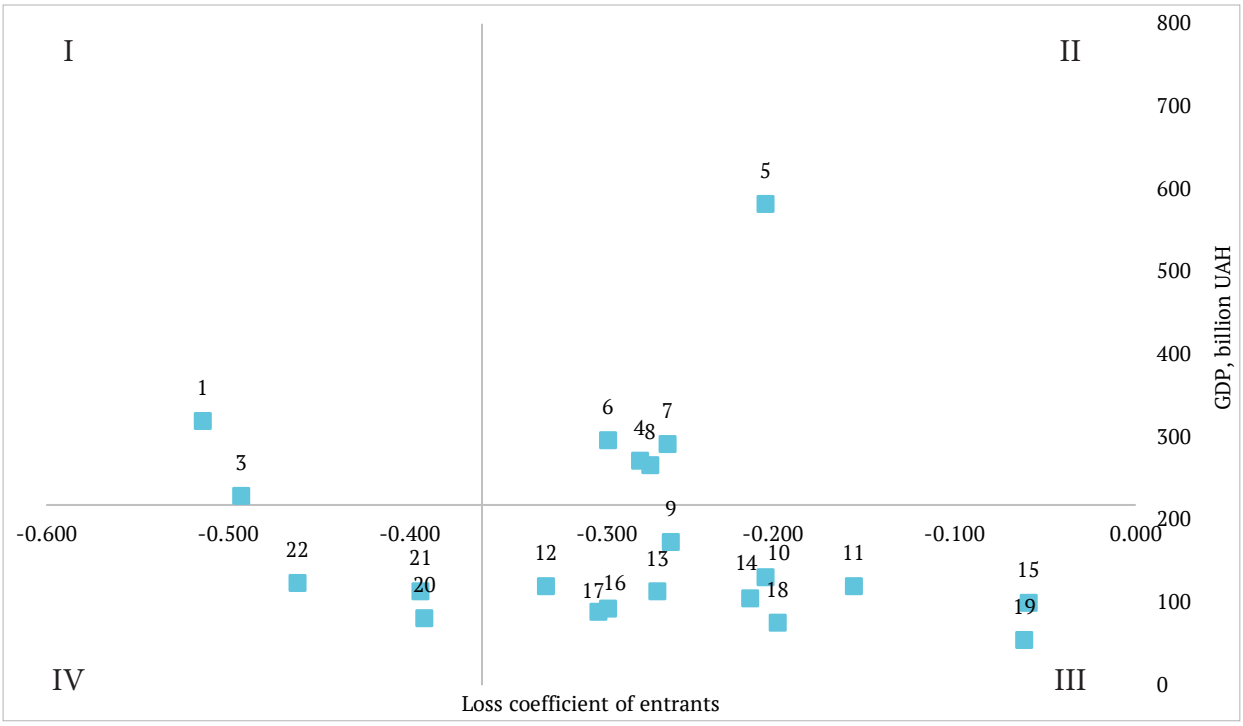

Figure 3. Results of the clustering of Ukraine's regions by the volume of contribution to GDP and the loss coefficient of entrants to PPHEIs

Source: made by the authors

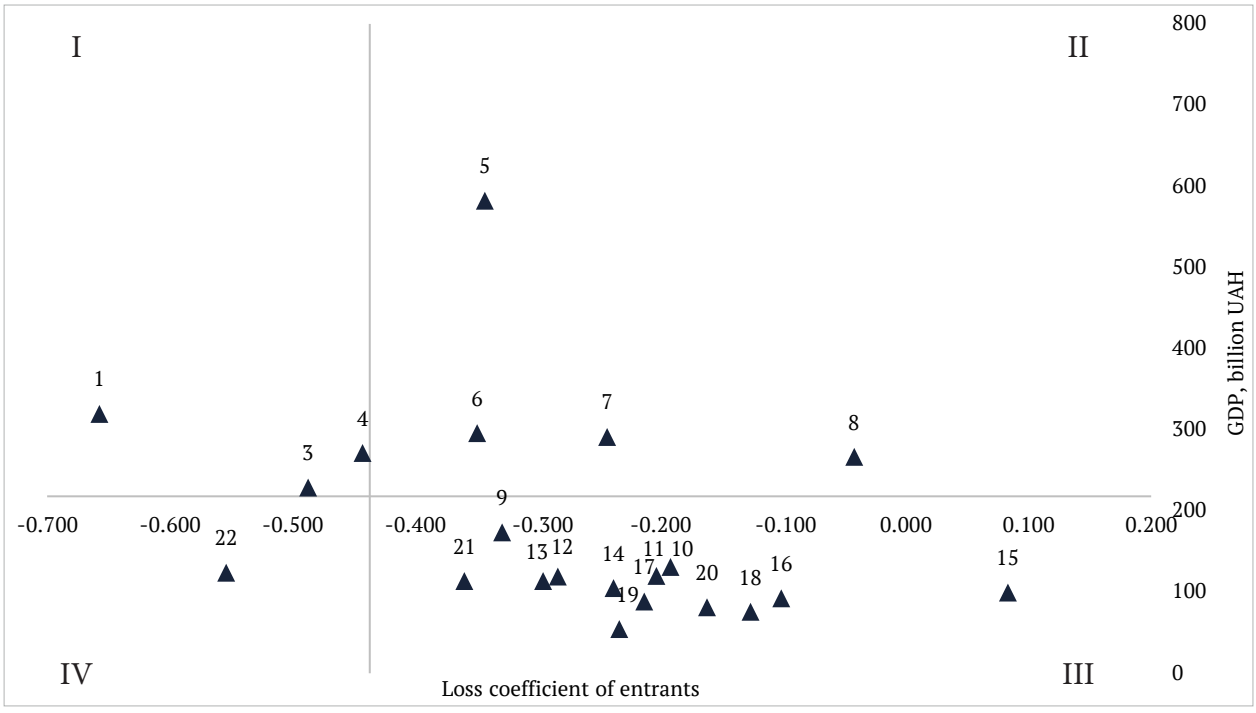

Figure 4. Results of the clustering of Ukraine's regions by the volume of contribution to GDP and the loss coefficient of entrants to HEIs

Source: made by the authors

Quadrant III: regions whose educational institutions do not need support, based on the indicators under consideration. Insignificant loss of graduates, the rate of loss of entrants is better than the average for Ukraine; the contribution to the country's GDP of each of these regions is below the average for Ukraine. Quadrant III includes other regions of Ukraine except Mykolaiv Region, which is included in Quadrant IV, and Zhytomyr and Ternopil Regions, in relation to the PPHEIs entrant losses. The total contribution of 13 regions of Ukraine in the III quadrant to the country's GDP is only 25%, with almost 30% of taxpayers registered. The learning losses of these regions will have a relatively smaller impact on future economic development in the context of human capital, given the reduced level of entrant losses and the insignificant contribution of these regions to the creation of GDP and, in fact, the country's recovery and development potential.

Quadrant IV: regions whose educational institutions do not need support, based on the indicators under consideration. Significant losses of entrants (the coefficient is worse than the average for Ukraine); the region's contribution to the country's GDP is below the average for Ukraine. The significant level of losses of entrants is compensated by a small share of the region's contribution (less than 2.5%) to the creation of Ukraine's GDP. Learning losses are a negative phenomenon, however, for the regions of the IV quadrant (Table 1), their influence on the dynamics of economic development indicators of the country is almost insignificant. The clustering of regions can be the basis for determining the directions of priority investment in education to overcome learning losses and gaps in the context of strengthening human capital and future economic growth.

The given characteristics of learning losses by educational institutions in the regional aspect, and the role of a certain region in the formation of human capital are the initial conditions of the post-war recovery of Ukraine. The only conditionally positive consequence of the transition to a distance form of education in such conditions is the acquisition of experience in choosing digital technologies. The article by M.C.D. Villasol (2021) examines the changes in the use of digital technologies during the transition of students from face-to-face learning to online learning, which was due to the COVID-19 pandemic. Adaptation to study in a new format allowed students to evaluate all aspects of this process, identify advantages and disadvantages. This experience will be very useful when choosing digital technologies after the lifting of pandemic restrictions and the transition to face-to-face learning. During the pandemic, the global educational community was forced to conduct an audit of various software products for the educational process. For example, the article by S. Sriworapong *et al.* (2022) presented the results of the assessment of the quality of online education in higher education in Thailand. The authors gave comparative characteristics of various educational platforms. Leaders turned out to be those who enable the implementation of a game component in the educational process. These are the only conditionally positive consequences of the prolonged pandemic and war for the current state of the economy and the formation of human capital.

To overcome the negative consequences, a system of organizational and economic measures is proposed to equalize access to quality education for different segments of the population, which will create an objective basis for eliminating learning gaps and restoring human capital. These include the creation of attractive conditions for the return of children with their parents from abroad and internally displaced families, such as: development and introduction of a temporary housing fund system; financing the restoration of the housing stock, educational, cultural and sports infrastructure, health care system; provision of a safe and accessible learning environment (shelters, bomb shelters). It is important to create acceptable conditions for employment and business development: to improve the organization of the labour market taking into account the needs of returning families; to simplify obtaining permits as much as possible. After the end of hostilities, it is necessary to return to the pre-war version of Resolution of the Cabinet of Ministers of Ukraine No. 179 "On Approval of the National Economic Strategy for the Period up to 2030" (2021). It provides significant tax incentives for business development. In the field of monetary regulation, in order to stimulate economic activity and economic growth, the National Bank of Ukraine (NBU) should also use various tools, such as regulating the level of banks' required reserves (to stimulate economic activity and economic growth, the NBU reduces banks' reserves); regulation of the discount rate (in order to stimulate economic activity and economic growth, the NBU lowers the discount rate), etc. Accordingly, under certain programs, banks can introduce preferential lending to certain business entities.

The system of measures to eliminate learning losses includes the following components. The development of a system for eliminating learning losses in basic and specialized high schools should include methods for assessing learning losses for each year of study and methods for compensating for these losses based on adjusting the content of academic disciplines and curricula. The system of vocational education and training is currently in decline, which is unacceptable, especially given the need to restore Ukraine's economy. A significant expansion of the system of vocational training is needed to meet the needs of the labour market. Economic recovery processes require the availability of skilled workers in all areas. In construction – master builders, carpenters, masons, electricians, plumbers and other specialists will be needed for the restoration and construction of new residential buildings, roads, bridges, schools, hospitals and other infrastructure facilities. In agriculture – farmers, agronomists, veterinarians and other specialists in the field of agriculture will be necessary to restore the agricultural sector, which may be affected by the conflict. In industry – workers from metallurgy, chemical industry, light industry and other industrial workers will help to restore and raise production. In medicine – nurses, pharmacists and other medical professionals play a critical role in providing medical care to the public, in disease prevention and control programs, and in the rehabilitation of victims. Workers in the hotel business, restaurants, transport and other workers in the field of tourism can help restore and develop the tourism industry of Ukraine, which in turn will help attract foreign investment and create jobs. In general, vocational training should prepare a wide variety of workers who will work together to restore and develop the economy and infrastructure of Ukraine.

The need to eliminate learning losses in higher education is no less urgent than at previously mentioned levels. Economic recovery is impossible without specialists with higher education diplomas, so it is necessary to develop and implement a system for eliminating learning losses in training specialists in higher education, which should include a methodology for assessing learning losses and a technology for drawing up an individual learning trajectory for each student. It is necessary to ensure the flexibility of learning on the basis of increasing the ability of students to choose their own learning pathway, particularly through individualized learning, interchangeable module curricula, Massive Open Online Courses programs, and flexible learning schedules. It is worth continuing the digitization of education based on the growing use of technologies and information systems in the educational process, including online courses, electronic textbooks, and distance learning. Developing lifelong learning based on the development of adult education programs, vocational training and retraining. Streamlining the network of HEIs in order to improve the quality of training of specialists in higher education in the conditions of recovery of Ukraine's economy (Ponomarenko, 2021).

In the post-war period, the role of universities that have close professional relations with enterprises and organizations of a particular industry increases significantly at the micro level. This gives them the opportunity to train specialists for specific jobs with a certain range of professional competencies. In the learning process, it is necessary to strengthen the emphasis on the development of the following personal competencies: critical thinking, creativity, communication and social competence. Economic recovery requires not only skilled workers, but also professional, practice-oriented engineering, technological, economic and managerial personnel with higher education diplomas for the micro level. Engineering, technological, economic and managerial specialists should be trained with a focus on the business of a particular industry so as not to waste time on retraining. In the post-war period, at the micro level, there is no place for economists, managers, technologists, engineers for all branches at the same time. In the process of forming a competent specialist, the entire educational process in the professional component should focus on a specific industry. At the micro level, economists, managers, engineers, technologists are needed separately for construction, mechanical engineering, metallurgy, transport, trade, etc. On average, the retraining of economists and managers with higher education diplomas, who were trained without reference to a specific industry, takes from one to three years to be able to work at a specific enterprise.

In this context, the role of the dual form of education is significantly increasing, which requires improvement of the legislative framework. A considerable increase in the practical component of the educational process in HEIs is impossible without a radical restructuring of the state order system for specialists with higher education diplomas. At the meso-level and macro-level in the post-war period there will be other trends, with the focus on interdisciplinary education. After the war, there will be a need for specialists able to work in interdisciplinary teams to solve the complex problems associated with the recovery and development of regional and macro economies. The trend towards interdisciplinary forms an objective need for advanced training with the help of microcredit training (4-6 credits). For example, "Entrepreneurship".

The structure of Ukraine's needs for specialists with higher education diplomas in relation to specialties should be determined by the labour market. However, as research by V. Ponomarenko (2020) showed, the choice of specialty made by entrants often depends neither on the needs of the labour market nor on the cost of education. Therefore, the state should regulate the demand of entrants in relation to specialties through the state order system. The existing system is formally student-oriented, but in practice it does not ensure the necessary quality of training, since the state order for the training of specialists in a certain specialty is often given to HEIs, which do not have the opportunity to conduct high-quality training of relevant specialists. Dispersion of the state order in a certain specialty among HEIs, which from year to year enrol less than 10 entrants collectively for budget and contract forms of education, nullifies both practical and theoretical training of specialists. The state order should be given to HEIs of a certain specialization, which is confirmed by the enrolment of entrants according to data from USEDE for the previous 3-4 years (Ponomarenko, 2020).

The application of the proposed approach is one of the regulatory aspects of the formation of human capital, in accordance with the strategic needs of the country's economy. In the post-war period, the social responsibility of HEIs should increase. They should actively support initiatives aimed at helping war victims, internally displaced persons and veterans. This may include the creation of assistance programs, conducting research and implementing projects aimed at improving the socio-economic situation of affected groups, including disabled war veterans.

Agreeing with the statement of D. Shyian & Ye. Sevrukova (2021) on the importance of the level of education, its quality for the formation of human capital, it should be noted that in the study, the authors focus on the existence of differences in opportunities for people from large cities and small towns and the desire to use these opportunities. It is the level of education that determines the readiness and practical actions of individuals for self-development and ensuring the improvement of their own qualities. The authors determine the quality of human capital through the impact of the level of education and place of residence on the level of human income, and therefore on the share of the generated national income. The study presents the identified differences in certain socio-economic characteristics of human capital, depending on the level of education and place of residence of the person.

It should be noted that the problem of human capital losses due to the migration of the able-bodied educated population has worsened. Confirmation of the thesis that the safety factor is of paramount importance for "carriers" of human capital is reflected in the Deloitte report (Survey: Attitudes of Ukrainian refugees, 2023). According to Deloitte's conclusions, among the persons who were forced to leave the territory of Ukraine, the majority (more than 75%) have a high level of education: 47% have higher, university education, and 29% have professional (vocational and technical education). At the same time, according to the age structure of adults, the share of the active

population of non-retirement age from 18 to 59 is 82%, that is, these are the most productive human resources that could potentially work to create the GDP of Ukraine in the current time period. Costs for the formation of this human resource, i.e., education and health care costs, were incurred in the past in order to obtain an economic effect today. Deloitte's profile of refugees from Ukraine found that 86% of migrants have some concerns about returning to Ukraine, and almost 50% identified security as the main reason for staying in another country.

Quarantine due to the pandemic had a significant impact on young people. In their article, T. Ebert *et al*. (2022) presented the results of a study of the impact of quarantine on Israeli students physically, socially and psychologically, how the number of children suffering from anxiety and depression has changed. It has been found that many children experienced learning, social, emotional, and behavioural gaps during the lockdown and lost the skills to cope with everyday challenges due to social isolation. It is clear that the war will leave much more serious psychological effects on the population, particularly on the students, so HEIs should develop psychological support and counselling for students who have experienced war or witnessed violence. In addition, they should initiate and develop various forms of assistance in psychological support of the population.

In the post-war period, against the background of negative psychological consequences, the formation of a high-quality individual emotional and intellectual portrait becomes extremely important. The components of this portrait are: emotional awareness, emotional intelligence, self-motivation, empathy, recognition of other people's emotions. These components de facto are the basis for the formation of high-quality personal competencies. Psychoemotional state is one of the important components of human capital. Along with education, the psycho-emotional component of human capital has a significant impact on its effectiveness in generating national income. In general, the proposed systematic measures to eliminate learning losses and learning gaps will certainly contribute to the restoration and increase of Ukraine's human capital.

CONCLUSIONS

The paper analysed the categorical basis of learning losses and learning gaps, and their impact on the current state of economic development, on the formation of human capital, and the impact on prospective indicators of the country's economic condition. The work summarizes the main factors that influenced the organization and implementation of the educational process during the pandemic and military actions at various levels of education. In combination with the data on migration processes, the structure of refugees, the predictive assessment of their return and the terms of return, it was possible to reveal the extent of the loss of human capital in Ukraine over the past year. Clustering of regions has been carried out depending on the size of educational losses, due to the volume of losses of entrants, and the share of a certain region's contribution to the creation of national income. The results of clustering made it possible to identify four clusters of regions. The regions of the first and second clusters need the greatest support, namely, the first cluster includes Kharkiv, Zaporizhzhia, Odesa Regions and the Kyiv city, and the second cluster includes Dnipropetrovsk, Lviv, Kyiv and Poltava Regions. These are the regions in which the largest economic potential of the country is concentrated, the share of entities that are the basis for the formation of GDP and national income of Ukraine. The role of human capital, the quality of human capital and its availability in these regions becomes crucial in the context of Ukraine's post-war recovery. The four regions of the first cluster account for almost 40% of Ukraine's total GDP, at the same time, these regions suffered the greatest learning losses due to the loss of entrants to regional HEIs as a result of the outbreak of active hostilities on the territory of Ukraine. Educational institutions in these regions need special support. This will contribute to faster compensation for learning losses and the restoration of human capital.

The paper also formulated the main measures for secondary and higher schools aimed at eliminating learning gaps and minimizing learning losses. Expanding the possibilities of a dual form of education in combination with the introduction of relevant legislative changes, actual individualization of education, strengthening of the practical component of training at all stages of the educational process with real integration of education and business, encouraging business to invest in education and science, including through the levers of preferential regimes. Providing psychological support and psycho-emotional restoration of human capital through restoration of emotional, social, psychological, behavioural, communication gaps. Implementation of an effective government policy in the field of ensuring the training of personnel needed for the post-war recovery of the country, including through the modernization of the state order system for the training of specialists in higher and professional pre-higher education. The implementation of a set of measures in the education system in combination with government policy and support for educational and business institutions is aimed at restoring human capital and developing the economy of Ukraine. A detailed study of the current and delayed impact of factors of a psycho-emotional nature on the quality of human capital, on the possibilities of its restoration, etc., can be the direction of further research into the problems of human capital formation. Among the directions of further research, it is also possible to determine the development of specific mechanisms for the development of regions and relevant educational institutions, taking into account the peculiarities of their territorial location.

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CONFLICT OF INTEREST

None.

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Особливості впливу освітніх втрат на формування людського капіталу в Україні в умовах воєнного стану

Анотація. За період пандемії та воєнного стану Україна втратила значну частину людського капіталу: оцінка цих втрат та розробка пропозицій їх відновлення є особливо актуальною в контексті необхідності відновлення економіки України в повоєнний період. Метою статті було дослідження та систематизація причин втрат людського капіталу та їх структури, визначення впливу освітніх втрат на формування людського капіталу, а також узагальнення пропозицій щодо компенсації понесених освітніх втрат та відновлення людського капіталу. У результаті аналізу наукових праць було виявлено низку факторів, які впливають на рівень освітніх втрат та освітніх розривів внаслідок карантинних обмежень у різних країнах світу, таких як: Німеччина, Іспанія, Бельгія, Китай. Систематизація інформації дозволила здійснити групування факторів, які впливають на освітні втрати в Україні, з виокремленням груп факторів, які обумовлені обмеженням можливості відвідування освітніх закладів, та груп факторів, що виникли внаслідок воєнних дій в Україні. В роботі обґрунтовано наявність регіональних відмінностей виникнення освітніх втрат та їх впливу на формування людського капіталу. Проведено кластеризацію регіонів за ознаками втрат вступників у закладах освіти та внеском регіону в створення валового внутрішнього продукту України. Результати кластеризації дозволили визначити пріоритетні напрямки відновлення людського капіталу. За результатами досліджень запропоновано заходи усунення освітніх втрат та освітніх розривів для закладів освіти різних рівнів, які можуть бути застосовані на практиці в повоєнній відбудові економіки країни

Ключові слова: економічний розвиток; заклади освіти; валовий внутрішній продукт; індекс людського капіталу; продуктивність наступних поколінь; якість