

Demographic Sustainability of Ukraine and Its Changes Caused by the Russian-Ukrainian War

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Abstract

The article's main tasks include analyzing changes in the main parameters of Ukraine's demographic sustainability before the current full-scale war (1989–2021) and assessing the quantitative, structural, and territorial demographic changes caused by it. The databases of the State Statistics Service of Ukraine and the International Organization for Migration, official reports of the Ukrainian Government, and expert data are the primary sources of demographic statistics. I used the index analysis tools to study changes in the reproductive and age-sex balances in Ukraine and its regions. Since the mid-1990s, Ukraine has been experiencing a deepening demographic reproduction crisis, manifested in a large-scale population decline and a deterioration in age and gender balance. Using the cluster analysis method, the demographic zoning of Ukraine is carried out. Russia's full-scale invasion has catastrophically weakened Ukraine's demographic sustainability. As a result of the war, tens of thousands of Ukrainian citizens died, and millions migrated, which deepened significant deformations in the sex and age structure of the population. The obtained results can be used to develop social and demographic policy measures. The study's limitations are related to the lack of reliable migration data.

Keywords

Age-sex structure; demographic reproduction; demographic sustainability; Russian-Ukrainian war; Ukraine's population

Introduction

The demographic development of Ukraine in the last three decades has been characterized by a steady deterioration of quantitative and qualitative parameters of the population, resulting in a demographic crisis. An extremely low birth rate combined with a consistently high mortality rate resonated with the increased external migration activity of the population. It has resulted in a steady annual population decline and violation of its age-sex structure (Pyrozkhov, 2004). The detailed historical analysis of transformations of demographic processes in Ukraine (mortality, fertility, marriage, divorce, migration), in retrospect, shows the patterns of demographic transition, depopulation, and population aging (Coleman, 2022; Hladun, 2018). Other threats to Ukraine's demographic security include the degradation of family institutions, health deterioration, premature mortality, reproductive losses, and migration risks (Hladun, 2020; Tsvihun, 2013).

One of the defining parameters of demographic sustainability is the age and sex population proportions. Europe's population is steadily aging (European Commission, 2021). Noticeable regional differences between the east and the west of Ukraine, convergence of urban and rural population aging rates, and a steady increase in the share of post-working age people are peculiar to the aging of the population in Ukraine (Tesliuk & Krupin, 2019). Even before Russia invaded Ukraine on February 24, 2022, Ukraine was one of the most demographically challenged countries in the world. The current Russian-Ukrainian war, the largest in Europe since World War II, confirms the need to analyze demographic parameters. They should be considered necessary to ensure public safety and sustainable development (Meidutė-Kavaliauskienė et al., 2020).

This war could cause a demographic catastrophe in Ukraine. Its onset depends on the duration and intensity of the war and its demographic consequences. Decisions to strengthen Ukraine's demographic sustainability should consider trends in pre-war demographic change and large-scale deformations in population structures caused by the war. To improve demographic sustainability in the current context, it is advisable to consider the experience of post-war demographic recovery and sustainability of Croatia (Živić, 2021) and the demographic risks of non-return of Ukrainian migrants (Kulu, 2023).

Research materials and methods

The approach to assessing the system's sustainability is based on the concept of sustainable development, which involves the establishment of a long-term equilibrium of three subsystems: environmental, economic, and social (United Nations, 1992). Demographic sustainability is also considered as one of the subsystems in the sustainability system. This comprehensive approach involves an in-depth analysis of both purely demographic parameters and socioeconomic factors (Lutz et al., 2002).

This article considers demographic sustainability in its narrow sense as the ability of the demographic sphere of a country or region to maintain a stable population with optimal demographic reproduction rates and proportions of the sex and age structure. This reflects modern scientific approaches that understand the meaning of this concept as the maintenance of a constant population size that can ensure at least simple reproduction (Sleebos, 2003) and balance between large age groups, i.e. when the optimal ratio between these groups in terms

of their size and growth is achieved (Oliveira Roca & Leitão, 2005; Roca & Oliveira Roca, 2014). In this sense, quantitative indicators of demographic sustainability include natural population movement and migration, sex and age population structure, marriage and divorce rates, life expectancy, demographic burden, and quantitative ratios between sexes and age groups.

The demographic sustainability of Ukraine and its regions was analyzed based on ten indicators (Table 1). The index method was used to compare and present their changes over time. For each indicator, the threshold or average value is determined. For Indicators 1–2, 7, 9, and 10, the maximum permissible value from the point of view of demographic sustainability is calculated (marked as *lim* in Table 1). For Indicators 3–6 and 8, the threshold value is compared with the European Union (EU), which consists of 27 countries (EU-27), average as of January 31, 2020 (Eurostat, 2023), while for Indicators 3, 4, 6, and 8 for their average values in 2002–2021 and Indicator 5 in 1989–2021 (marked as *av-EU* in Table 1 and further in the article).

Table 1: Demographic Sustainability Indicators and Their Threshold/Average Values

| Demographic Sustainability Indicators | Threshold (<i>lim</i>) or EU average (<i>av-EU</i>) values | Partial indices |
|--|--|-----------------|
| 1. Vitality rate: <i>the ratio of births to deaths</i> | 1 (<i>lim</i>) | x^v |
| 2. Total fertility rate: <i>the average number of children born to a woman during the entire reproductive period</i> | 2.1 (<i>lim</i>) | x^{tf} |
| 3. Life expectancy: <i>years</i> | 79.8 (<i>av-EU</i>) | x^{le} |
| 4. Gender gap in life expectancy: <i>the difference in average life expectancy between women and men, years</i> | 6 (<i>av-EU</i>) | x^{gle} |
| 5. Infant mortality rate: <i>number of children who died before the age of 1 per 1,000 live births</i> | 6.6 (<i>av-EU</i>) | x^{im} |
| 6. Mortality rate of the working-age population: <i>per 1,000 population aged 16-59 years</i> | 2 (<i>av-EU</i>) | x^{mwa} |
| 7. Youth-to-older-adults ratio: <i>children aged 0-15 to people over 60 ratio</i> | 1 (<i>lim</i>) | x^{yo} |
| 8. Total dependency ratio: <i>people aged 0-15 and 65+ to people aged 16-64 ratio, %</i> | 51.1 (<i>av-EU</i>) | x^{td} |
| 9. Men-women reproductive ratio: <i>ratio of women to men aged 15-49</i> | 1 (<i>lim</i>) | x^{ra} |
| 10. Younger-to-older working-age population ratio: <i>ratio of people aged 15-39 to people aged 40-64</i> | 1 (<i>lim</i>) | x^{wp} |

Note: Author's draft using data from Eurostat (2023)

This comparison is conditional, but it shows the differences in the parameters of demographic sustainability of Ukraine and the European Union (EU) and allows for assessing the direction of their demographic development vectors. This analysis can serve as a starting point for adapting the European experience in developing and implementing sociodemographic policy from the perspective of Ukraine's accession to the European Union. The State Statistics Service of Ukraine (SSSU) (2022) database is the primary source of the demographic statistics used for Ukraine and its regions. The study covers 1989–2021, as the data for 2022 and 2023 is incomplete and not yet published by Ukraine's official government agencies. The analysis did not include migration indicators since official data from the SSSU reflects only a part of the stationary migration of Ukrainian citizens, namely those who deregister at their residence. Since labor migration and, to a lesser extent, educational migration were the main types of migration until 2022, Ukrainian statistics did not record the migration of citizens who obtained temporary or permanent residence abroad while remaining registered in Ukraine.

As a result of Russia's annexation of the Autonomous Republic of Crimea and the City of Sevastopol in 2014, starting that year and until now, Ukraine has not provided official demographic data on the peninsula. Data on the partially occupied Donetska and Luhanska oblasts since 2014 have been incomplete and cannot adequately reflect the demographic situation of the entire territory of each region. Therefore, these four regions were excluded from the assessment of demographic sustainability.

Partial indices (x) have been calculated for each of the ten indicators (Table 1). Two general demographic sustainability indices are also calculated: the demographic reproduction index (X^{DR}), determined based on six indicators (1–6), and the age-sex balance index (X^{ASB}), determined based on four indicators (7–10). General indices of demographic sustainability are calculated as an arithmetic mean of partial indices. The indices serve as indicators of the demographic sustainability status, as per the stipulated conditional scale: 0.9 or higher corresponds to a status of *conditionally safe*, 0.7–0.9 is categorized as *threatening*, 0.5–0.7 signifies a *critical* status, and values less than 0.5 are indicative of a *catastrophic* situation. When analyzing the demographic sustainability indices of Ukraine and its 23 regions over a long period (1989–2021), the duration of their stay in a given interval is essential. Due to the ongoing demographic crisis in Ukraine, I consider it unnecessary to set an upper limit in the *conditionally safe* range.

The study also uses cluster analysis, such as Tsvihun (2013), Roca and Oliveira Roca (2014), Kastreva and Patarchanova (2021) used to group the regions of the state by indicators of demographic sustainability for the implementation of state and regional sociodemographic policy. The tree clustering method was used for cluster analysis. The input data included ten indicators of demographic sustainability for 2021: those listed in Table 1 and the indicator “population decline in 30 years (1993–2022), %”. The regions of Ukraine were divided into clusters according to the demographic development indicators based on City-block (Manhattan) distances, and the clusters were created using Ward's method.

The quantitative assessment of the impact of the Russian-Ukrainian war is based on official data from the International Organization for Migration (IOM) (2023a, 2023b) and the United Nations (UN) (Janowski, 2023; United Nations High Commissioner for Refugees, 2023). Without state statistics on population, structural-demographic deformations are estimated using sociological surveys, expert assessments, media reports, etc. The borders of the occupied territories and the front line are considered based on the data of DeepState Map (n. d.).

Research results

Demographic sustainability of Ukraine in 1989–2021

The population decline in Ukraine began in 1993. A sharp decline in fertility and a negative migration balance led to a high rate of decline in the following ten years (1994–2005) by 0.7–0.9% per year (340,000–520,000 people). Later, the rate slowed down somewhat (0.2–0.5% or 81,000–198,000 people in 2009–2017), mainly due to a slight increase in the birth rate as a result of those born in the 1980s entering the reproductive age, as well as a change in the nature of migration from stationary to mostly seasonal labor migration, which is not reflected in official statistics.

In 2014, the demographic crisis was greatly aggravated by Russia's annexation of the Autonomous Republic of Crimea and the City of Sevastopol and the hybrid war unleashed by this aggressor in eastern Ukraine, which led to the emergence of Russian-controlled pseudo-republics, but in fact, the terrorist organizations Donetsk People's Republic (DPR) and Luhansk People's Republic (LPR). The war caused a powerful wave of internal displacement (1.47 million internally displaced persons (IDPs) by mid-2021), deepened regional imbalances in population distribution, and generated a general socioeconomic crisis, which has become an essential factor in the deterioration of the demographic situation in the country. There are 2.3 million Ukrainian citizens in Crimea under Russian occupation and about 3.5 million in the Russian-controlled DPR and LPR. Russian immigrants began to arrive in Crimea actively, which impacted, in particular, the linguistic and ethnic composition of the peninsula's population.

The COVID-19 pandemic has become another factor in the deterioration of the demographic situation, causing a significant increase in mortality in 2020 and 2021 by 21,300 and 87,600 people, respectively. The rise in mortality combined with the decrease in the birth rate has once again increased the rate of population decline: 0.8% and 1% in these years. A total of 112,478 people have died of coronavirus infection in Ukraine since the beginning of the pandemic until mid-2023 (Ministry of Health of Ukraine, 2023). Due to mass vaccination, the disease has ceased to be widespread, so the Cabinet of Ministers lifted quarantine on July 1, 2023.

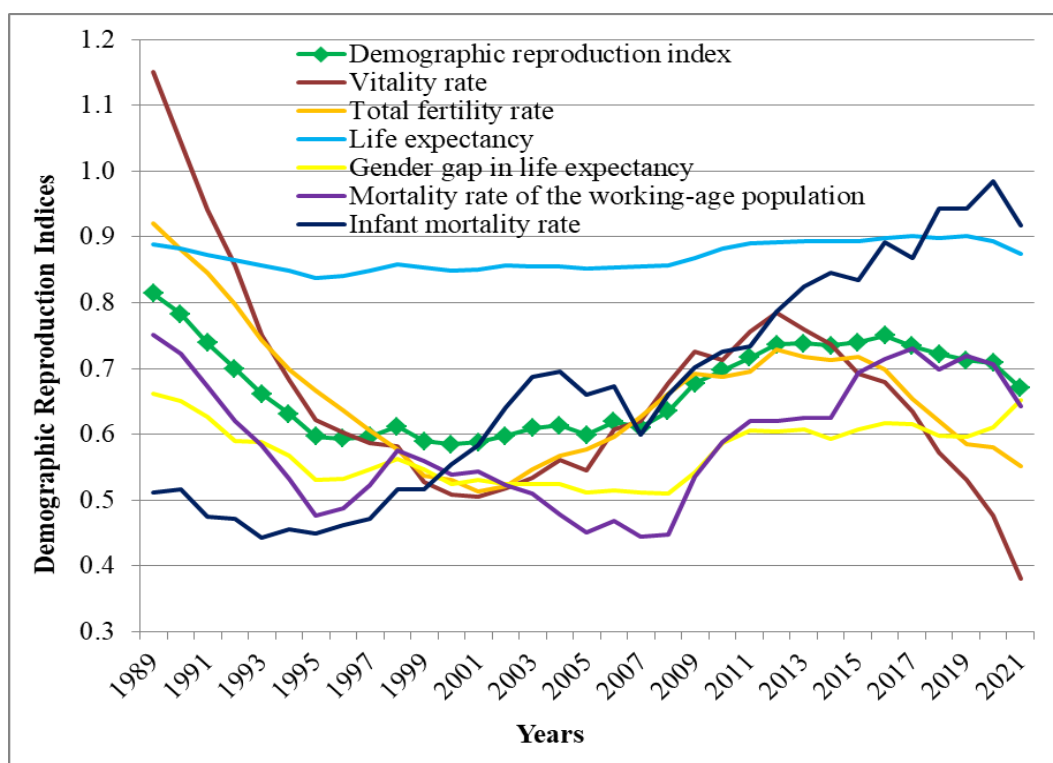
Consistently high levels of external migration have aggravated the demographic crisis. According to experts, in 2019–2021, about 2.5–3 million Ukrainian labor migrants were abroad simultaneously (Slovo i Dilo, 2021), primarily those in their reproductive years, affecting the birth rate and generally destabilizing demographic processes in Ukraine. A combination of negative demographic factors led to an absolute decrease in the population of Ukraine (within the internationally recognized borders) in the last 30 years, 8.4 million people (16.2% of the total population), the most significant absolute rate among the countries worldwide in this period. Given these trends, the United Nations estimates that by the end of the century, 20.4 million people will live in Ukraine (United Nations, 2022).

The authors of another demographic projection (Vollset et al., 2020) substantiate the population decrease in Ukraine in this period by 60%, namely to 17.6 million people in 2100. In a medium scenario, researchers of the Ptoukha Institute for Demography and Social Studies indicated 22.4 million people at the beginning of 2100 (Hladun, 2020). However, Ukraine can reach this population size only if the pre-war demographic trends improve. If the negative demographic characteristics persist, the population could decrease by 13.2 million. It should be taken into account that all of the above projections were made, taking into account the population number and structure before the outbreak of a full-scale war. The state of demographic reproduction as the primary demographic sustainability criterion in 1989–2021 is assessed by six indicators and the general demographic reproduction index (Figure 1).

The vitality rate shows the highest amplitude values of all analyzed demographic reproduction indicators. An incredibly rapid decline in this indicator (from 1.151 in 1989 to 0.505 in 2001) is caused by a sharp drop in the birth rate during the socioeconomic crisis in the 1990s. After a specific stabilization in the 2000s, the vitality rate fell again to a catastrophic level of 0.381 in 2021 (halved in the ten years), which is related to the increase in mortality (in particular, as a result of COVID-19) and the annual decrease in the number of births. In the EU-27, the vitality rate has been above 1 for a long time. Only in 2012, it began to decline to

0.896 in 2019, and in the following years, it fell sharply to 0.785 and 0.772, mainly due to a jump in mortality (by 11–14% compared to 2019).

Figure 1: Demographic Reproduction Indices in Ukraine (1989–2021)



Note: Author's draft based on data from the State Statistics Service of Ukraine (2023)

The trend of the total fertility rate is somewhat milder than that of the vitality rate but similar in shape. The longevity of the fertility crisis is illustrated by the fact that in Ukraine, the value of this indicator above the threshold (2.1) was last seen in the mid-1970s (Hladun, 2018). After hitting an all-time low of 1.095 in 2001, the index grew slowly until 2015 to 1.54 in 2012 and fell to 1.16 in 2021. This indicator has remained stable in the European Union at 1.5–1.57 over the last 15 years.

Average life expectancy is the only demographic reproduction indicator with consistently higher values than other indicators. Moreover, a slight positive trend in this indicator is worth noting, from a minimum of 66.8 years in 1995 to 72 years in the pre-COVID 2019 year. However, this rate was 10% lower than the *av-EU*.

There is a long-standing gender gap in life expectancy in Ukraine, which is 1.5–2 times higher than the *av-EU*. The difference in life expectancy between men and women in the most crisis-ridden 2000s reached 11–11.8 years (62.1–62.7 years for men & 73.5–74.3 years for women). In 2021, it returned to the 1990 level of 9.2 years.

Infant mortality is the only demographic reproduction indicator showing a clear improvement trend. Having been at a deficient level in the 1990s (12.8–14.9%), it fell to 9.1–11.9% in the 2000s and then gradually decreased to 6.7% in 2020 (*av-EU* at 6.6%).

The persistently high mortality rate of the working-age population is one of the characteristic features of demographic decline in Ukraine. In 2004–2008, it was more than twice higher than

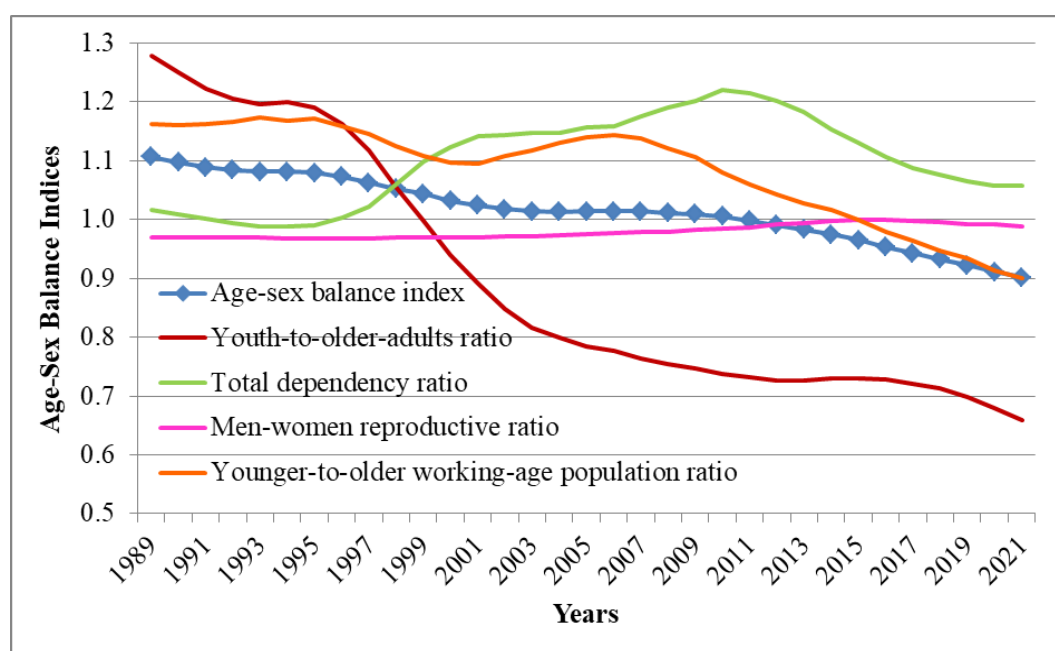
the *av-EU*. In 2015–2020, this indicator stabilized at 2.7–2.9% but deteriorated again in 2021 (3.1%).

Since 1990, Ukraine's general demographic reproduction index has always been below 0.8. The most unfavorable years for Ukraine were 1995–2007; X^{DR} was within the critical values of 0.585–0.619. Subsequently, improvements in most indicators (except fertility) have stabilized demographic reproduction to some extent; in 2011–2020, X^{DR} remained at 0.709–0.750 but deteriorated dramatically to 0.670 in 2021.

The age and sex structure of the Ukrainian population is relatively stable compared to the demographic reproduction but shows a long-term trend of worsening balances (Figure 2).

The most critical is the balance between children (0–15 years old) and older people (60+ years old). Since the first half of the 1990s, the youth-to-older-adults ratio has declined rapidly to 0.73 in 2011–2016 and then to its minimum value of 0.645 in 2021. The youth-to-older-adults ratio in the European Union was generally lower than in Ukraine, as the population aging started earlier. Over the past decade, this indicator has decreased by 0.01 per year to 0.579 in 2021.

Figure 2: Age-Sex Balance Indices in Ukraine (1989–2021)



Note: Author's draft based on data from the State Statistics Service of Ukraine (2023)

The decrease in the demographic burden in Ukraine from 1995 to 2011 is mainly associated with the decline in the number of children. In 2006, older people began to outnumber children. This factor and a gradual transition of large groups of older working-age people to post-working age in the early 2010s led to an increase in the total dependency ratio (48.3 in 2021). Still, it is lower than the steadily rising level in the European Union (56.5 in 2021).

The population's age structure in reproductive age was generally relatively favorable throughout the analyzed period. The number of women outnumbering men (968–970 men per 1,000 women in 1989–2001) gradually leveled off by 2017. Since then, there has been a slight preponderance of men (1.012% in 2021). The EU-27 is characterized by a constant

preponderance of men (1.020–1.021% until 2015), which increased sharply to 1.025% in early 2016 and 1.029% in early 2022.

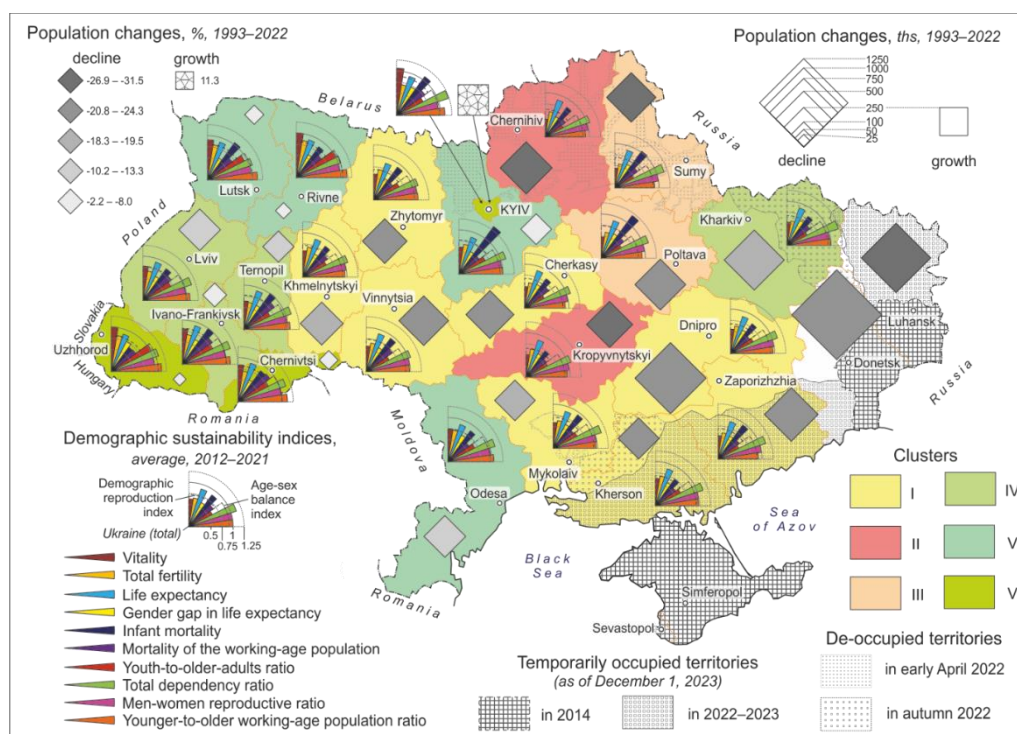
The decline in the birth rate in the mid-1990s and the entry into retirement age of a large post-war generation in the 2010s eventually led to a drop in the share of the younger working population below 1 in 2016. By early 2022, it was already approaching the pre-crisis level (0.901). In the European Union, this indicator dropped below 1 in 2008 and has steadily declined annually to 0.833 by the beginning of 2022.

Overall, the age-sex balance of Ukraine’s population is characterized by a steady downward trend. The population, which was younger than in the European Union, is gradually aging, with the age-sex ratio exceeding 1 in 2011 and steadily approaching a threatening level (0.902 in early 2022).

Regional demographic differences in Ukraine before the Russian invasion on February 24, 2022

The combination of demographic development factors has led to significant regional differences in the state and the development of demographic processes in the regions of Ukraine. Using the cluster analysis method, I made a demographic zoning of Ukraine based on 11 indicators of demographic stability. The regions of Ukraine are grouped into six clusters (Figure 3). Table 2 shows the average total indices (X^{DR} , X^{GAB}) in each cluster for the last ten years (2012–2021) and the rate of population decline (growth) in them for the previous 30 years (1993–2022). Figure 3 shows, in addition to the general ones, the average partial indices for each indicator of demographic sustainability (Table 1) in 23 regions of Ukraine.

Figure 3: Demographic Zoning of Ukraine and Regional Indicators of Demographic Sustainability



Note: Author’s draft based on data from the State Statistics Service of Ukraine (2023) and DeepState Map (n. d.).

The analysis identified six clusters in Ukraine. Clusters I, II, and III consisted of 12 central, northeastern, and southern regions, primarily in crisis and threatening states of demographic sustainability. These clusters can be conditionally combined into one group. The second group consists of 11 regions of Clusters IV, V, and VI, namely all western oblasts of Ukraine, Kyiv, and oblasts with centers with a population of over one million, characterized by mostly threatening and conditionally safe states.

Table 2: Demographic Sustainability Cluster Profile Before the Large-Scale War

| Cluster number/country | | I | II | III | IV | V | VI | Ukraine |
|---|-----------------------------------|-------|-------|-------|-------|-------|-------|---------|
| Partial average indices of demographic reproduction (2012-2021) | $\overline{X^{DR}}, (2012-2021)$ | 0.696 | 0.640 | 0.712 | 0.760 | 0.786 | 0.835 | 0.725 |
| | $\overline{x^v}$ | 0.565 | 0.455 | 0.462 | 0.685 | 0.813 | 0.970 | 0.625 |
| | $\overline{x^{tf}}$ | 0.646 | 0.608 | 0.568 | 0.632 | 0.762 | 0.741 | 0.657 |
| | $\overline{x^{le}}$ | 0.888 | 0.880 | 0.894 | 0.911 | 0.888 | 0.909 | 0.894 |
| | $\overline{x^{gle}}$ | 0.589 | 0.556 | 0.610 | 0.624 | 0.592 | 0.722 | 0.610 |
| | $\overline{x^{im}}$ | 0.876 | 0.779 | 1.110 | 0.927 | 1.024 | 0.874 | 0.884 |
| Partial average indices of age-sex structure (2012-2021) | $\overline{X^{ASB}}, (2012-2021)$ | 0.909 | 0.866 | 0.884 | 0.961 | 0.994 | 1.020 | 0.926 |
| | $\overline{x^{yo}}$ | 0.583 | 0.498 | 0.493 | 0.661 | 0.825 | 0.822 | 0.593 |
| | $\overline{x^{td}}$ | 1.101 | 1.061 | 1.145 | 1.159 | 1.090 | 1.165 | 1.128 |
| | $\overline{x^{ra}}$ | 0.989 | 0.983 | 0.990 | 0.982 | 0.985 | 0.974 | 0.994 |
| | $\overline{x^{wp}}$ | 0.961 | 0.922 | 0.910 | 1.044 | 1.076 | 1.118 | 0.988 |
| Population decline (growth) (1993-2022), % | | -21.2 | -29.6 | -25.4 | -13.0 | -7.8 | 4.4 | -16.2 |

Note: Author's draft based on data from the State Statistics Service of Ukraine (2023)

The regions of the first group (Clusters I-III) faced a significant decrease in population. General indices of demographic reproduction (X^{DR}) and age-sex balance (X^{ASB}), almost all indicators of demographic reproduction, and youth-to-older-adults ratio (x^{yo}) demonstrate the rates lower than the Ukrainian average within the critical and threatening states. Cluster I unites eight regions of the center and south of the country. They have relatively better vitality (x^v) and total fertility rates (x^{tf}), better youth-to-older-adults ratio, and lower decline rate than Clusters II and III. Cluster II (Chernihivska and Kirovohradska oblasts) had the lowest general indices of demographic sustainability (X^{DR} and X^{ASB}) and the worst rates of demographic reproduction indicators overall. Clusters II and III differ from all others in catastrophic vitality (x^v) and younger-to-older working-age population (x^{yo}) indices. However, Cluster III (Sumska and Poltavaska oblasts) have better life expectancy and mortality rates. Clusters I-III generally comprised regions with a prolonged demographic crisis and rapid population aging.

The population decreased significantly in the second group of regions (Clusters IV-VI). The overall and partial indices were generally better than the Ukrainian average. Among the clusters in this group, Cluster IV was the most crisis-ridden. It comprises three western Ukrainian oblasts and the Kharkivska oblast. Four indices: vitality (x^v), total fertility (x^{tf}), the gender gap in life expectancy (x^{gle}), and younger-to-older working-age population (x^{yo}), were in crisis interval. Meanwhile, Cluster V (Kyivska, Odeska, and northwestern oblasts) has only two critical indicators (gender gap in life expectancy, x^{gle} ; the mortality rate of the working-age population, x^{mwa}) and relatively low life expectancy (x^{le}). Clusters V and VI

have age-sex balance (X^{ASB}) close to one. In general, Cluster VI (Kyiv, Zakarpatska, and Chernivetska oblasts) had the best total and partial indices of demographic sustainability relative to other clusters (except for infant mortality, which has long been high in Zakarpatska oblast). This group of clusters is less demographically challenged, mainly due to traditionally higher birth rates and generally better demographic reproduction rates, as well as the concentration of the working-age population in cities with a population of over a million people and suburban areas.

The impact of a full-scale Russian-Ukrainian war on the demographic sustainability of Ukraine and its regions

Russia's full-scale war against Ukraine has dramatically exacerbated the demographic crisis, turning it into a demographic catastrophe in some regions. The lack of official demographic statistics limits the assessment of the impact of this war on demographic processes. Still, it is already possible to identify the main consequences in three dimensions: quantitative, structural, and territorial.

In quantitative terms, Ukraine has suffered and is suffering significant demographic losses: direct mortality (civilian & military) and emigration, and indirect reduction in the birth rate. The United Nations Human Rights Monitoring Mission in Ukraine (HRMMU) recorded data (as of November 21, 2023) on the loss of at least 10,000 civilians. However, these are only confirmed and documented data; their incompleteness is recognized by the HRMMU itself (Janowski, 2023). These do not include civilian casualties in the occupied territories, in particular, for example, in Mariupol, Lysychansk, Popasna, and Sievierodonetsk. It is currently impossible to verify, for example, information about 138,000 people who died in Mariupol for various reasons, including starvation and lack of medical care (as of mid-October 2022) (City of Mariupol, 2022). The Ukrainian authorities and the military do not disclose the number of Ukrainian soldiers killed. According to the New York Times (Cooper et al., 2023), citing U.S. officials, about 70,000 Ukrainian soldiers have been killed in the 18 months of war. More complete and reliable information on the number of civilian and military casualties may be available after the end of all hostilities on the territory of Ukraine. For now, I can argue that tens of thousands of Ukrainian citizens died as a result of the war.

Migration is an equally acute threat to Ukraine's demographic sustainability. Since the beginning of the invasion, about one-third of Ukrainians have changed their place of residence. According to the United Nations High Commissioner for Refugees (UNHCR) estimates (United Nations High Commissioner for Refugees, 2023), as of November 28, 2023, there were 6.32 million refugees from Ukraine in 21 months of Russia's large-scale war against Ukraine, of whom 1.244 million were in Russia. Information about the deportation of Ukrainian children to Russia is unverified, but it is crucial for understanding the scale of demographic deformations. The number of deported children is estimated at 260,000 to 700,000 (Ukrinform, 2023).

Due to the difficulties in recording border crossings, as well as the possibility of Ukrainian refugees leaving Russia for European countries, the number of refugees reported by the UN is likely to be different: in European countries, about 3.8–4.7 million, in Russia about 1.5 million (Vyshlinsky et al., 2023). The International Organization for Migration (IOM) (2023b) estimated the number of internally displaced persons (IDPs) in Ukraine to be 3.527 million as of October 2023. Moreover, about 4,573 million migrants (as of August 2023) have already

returned to their places of permanent residence (International Organization for Migration, 2023a).

Indirect demographic losses can be estimated after the war's end. Still, given the scale of migration and the deformation of demographic structures, a decline in the birth rate in Ukraine is expected. The analysis shows that the birth rate in Ukraine had been in a permanent crisis for a long time, even before the Russian invasion. Its further decline is Ukraine's most significant demographic threat during and after the war. Some experts believe that in wartime, this figure will fall to 0.7 (Zhukovska & Zakharchenko, 2022).

Significant deterioration of demographic sustainability is evident in changes in its other parameters. In addition to the actual increase in mortality, primarily among men of working age, the war caused an increase in morbidity. According to approximate unconfirmed estimates (Cooper et al., 2023), as of mid-August 2023, the Ukrainian army's losses in wounded amounted to 100,000–120,000. According to the United Nations Human Rights Monitoring Mission in Ukraine (HRMMU) (Janowski, 2023), as of November 21, 2023, the number of wounded civilians reached 18,500. Many Ukrainian citizens have post-traumatic stress disorder as a result of the war. The studies of Karatzias et al. (2023) showed that 25.9% of participants met the diagnostic requirements for post-traumatic stress disorder (PTSD), and 14.6% met the criteria for complex post-traumatic stress disorder (CPTSD). These factors reduce life expectancy, increase the difference in the values of this parameter between men and women, and worsen the birth rate.

The projected decline in birth rates and increase in mortality will further deform the age structure of the population, leading to a shortage of workers in the future, a growing demographic burden on older adults, and an aggravation of social security problems for the increasing number of retired by age, military veterans, and war victims. The war-induced deformations of the sex structure of Ukraine's population, which had long remained balanced in the reproductive age, should be highlighted separately. The Ukrainian army has concentrated about 700,000 people in its ranks, of whom women make up only 7.1% (Butsko, 2023). Instead, women (over 80%, 2/3 of them of reproductive age), children (1.742 million as of early April 2022, or 23% of the total number of children in Ukraine), and older adults prevail among Ukrainian displaced people abroad as a result of the ban on conscripts traveling outside Ukraine (4Service Group, 2023). Marriage and family structures have undergone deformation due to the increase in single-parent and long-distance families, which, in addition to directly reducing the number of births, affects the development and upbringing of children and creates gender and age gaps in regional communities.

The war has aggravated the territorial and demographic disparities that existed until 2022. The demographic situation is most acute in the frontline areas and in the Ukrainian territories occupied by Russia (Figure 3). As of December 2023, 18% of Ukrainian territory was occupied (108,441 square kilometers), and 43,362 square kilometers were liberated in 2022 and 2023 due to counteroffensives (DeepState Map, n. d.). The destruction of towns and villages in Luhanska and Donetsk oblasts has already led to a local demographic catastrophe: only 15–20% of the population remains in some towns (compared to January 2022), and some villages are deserted.

In addition to the forced transfer of Ukrainian children to Russia or Crimea, which, according to the Convention on the Prevention and Punishment of the Crime of Genocide (UN General Assembly, 1948), is one of the signs of genocide Russia has committed. It is executing many war crimes and crimes against humanity in the occupied territories: murder, capture,

persecution, imprisonment, sexual violence, and forced mobilization of Ukrainian citizens into the Russian army. In addition, in the case of prolonged occupation, Russia actively resettles its citizens to the occupied territories. According to estimates, 500,000–800,000 Russians have moved to the Autonomous Republic of Crimea and the City of Sevastopol during the 8-year occupation (Letiak, 2022). After the de-occupation of these territories, Ukraine should expect the flight of a part of the population, such as immigrants from the Russian Federation and collaborators from among Ukrainian citizens.

More than 3 million people have fled the war-torn eastern and southern regions. Many became IDPs for the second time. A large share of IDPs has been residing in Zaporizka and Kharkivska oblasts and unoccupied parts of Donetska and Luhanska oblasts since 2014–2015. Kharkivska, Dnipropetrovska, Kyivska, Lvivska, and Poltavska oblasts and unoccupied part of Zaporizka oblast host more than half of all IDPs in Ukraine (International Organization for Migration, 2023b). Most of the areas of hostilities were already in a demographic crisis before the invasion. Instead, the western regions of Ukraine, Kyiv, and Kyivska oblast with relatively better demographic sustainability became the recipients of IDPs, thus temporarily quantitatively compensating for those who left abroad and other regions of Ukraine, a significant part of whom returned in 2022. However, such external and internal migration may be short-lived, depending on the war's course. Their return to their places of permanent residence depends on many factors: the duration of the war, the degree of destruction of housing and infrastructure, the development of the labor market, the pace of demining, etc.

Discussion

The assessment of demographic processes in Ukraine is generally complicated by the lack of many critical demographic characteristics of the population, as the last census was conducted in 2001. In particular, the lack of reliable migration records at the state and regional levels makes it impossible to include this indicator in the analysis. The higher intensity of external labor migration in the western regions of Ukraine weakened the demographic and reproductive capacity. It worsened the age-sex population structure, but demographic sustainability remained generally higher.

The conditional division of Ukraine's regions into two groups can be explained not only by the migration attractiveness of large cities, which, together with suburban settlements and districts, concentrate the population in the working (and at the same time reproductive) age due to the consistently high demand for labor. Analyzing the regional peculiarities of the demographic development of Ukraine since the beginning of the twentieth century, I see that the differences between the two groups of regions reflect the historical factor, namely the length of time certain regions were part of the Soviet Union. The western regions, which today have significantly better demographic sustainability, were officially occupied by the Union of Soviet Socialist Republics (USSR) after the outbreak of World War II in 1939. Therefore, they were spared the horrific repressions of the Soviet authorities in the 1920s and 1930s, and most importantly, especially the Holodomor genocide in 1932–1933, which caused millions of direct and indirect demographic losses, destroying entire generations of Ukrainians and permanently changing the narratives of their demographic behavior.

This conclusion can explain the significant differences in the demographic development of these groups at the regional and subregional levels: for example, between the neighboring Rivnenska and Zhytomyrska oblasts of the Polissia area or Ternopil'ska and Khmelnytska

oblasts of the Podillia area. The current Russian occupation, accompanied by the repression of Ukrainian citizens, is also significantly changing the demographic profile of the occupied regions and settlements. Therefore, it is imperative to minimize the duration of the stay of Russian troops and the occupation regime on the Ukrainian territories.

Is a new demographic catastrophe possible in Ukraine? Given the critical state of many of the analyzed indicators of demographic sustainability, it could be caused by Ukraine's defeat or the end of the war on Russia's terms. In such a scenario, Ukrainian citizens in the occupied territories would be under constant threat of physical destruction, deportation, and/or assimilation. Freezing the war would mean a constant threat of conflict escalation, which would not contribute to the demographic recovery of the affected regions. The non-return of Ukrainian migrants will significantly limit the country's labor and economic potential, especially in occupied and war-torn regions. The integration of IDPs will leave acute social problems in the host regions. Ukraine is facing significant depopulation despite the likelihood of migrants returning (Shevchuk, 2023). To maintain the country's population of at least 30 million people, provided the economy recovers, about 300,000 immigrants are needed annually. However, despite the positive changes in quantitative demographic characteristics, this may cause several problems in the social and cultural spheres.

In general, the likelihood of a demographic catastrophe depends on several key factors, the most important of which is the end of the war and Ukraine's victory with the return of all occupied territories. In this regard, I already speak of local demographic catastrophes in the destroyed towns of Luhanska and Donetsk oblasts and in some villages in Chernihivska and Sumska oblasts, which are demographically depressed and destroyed as a result of the Russian invasion. Scientists at the National Academy of Sciences of Ukraine substantiated the primary role of six cities in the post-war resettlement of Ukrainians (Marushchak, 2023). They see the development of metropolitan areas as a solution to significant economic and social problems, contributing to sustainable demographic development. However, suppose certain cities (metropolitan areas) continue to concentrate more and more on population (both re-emigrants and migrants from other regions of Ukraine). In that case, there is a significant risk of deepening the demographic crisis in the regions of Clusters I-III and exacerbating imbalances in the sociodemographic development of the regions. These regions should not become peripheries and migration donors for large cities.

For this purpose, it is essential to understand the Russian-Ukrainian war not only as an armed confrontation for specific territories but also, according to the international law expert Vasylenko (2018), the war with Russia is existential (a threat to the existence of Ukraine as a state and Ukrainians as a state nation) and multi-vector (in addition to the military front, there is also a humanitarian front with its components: linguistic, cultural, historical, informational-propagandistic, and confessional). Therefore, Ukraine's demographic prospects must be secured by victory on the battlefield and in the social, humanitarian, and cultural spheres.

However, I believe that Ukraine's victory will not guarantee the improvement of the demographic situation either. In particular, the conditions of post-war peace and their observance will be necessary. Given the historical experience of the Russian state in its formally different but essentially equally totalitarian forms, the risk of revanchism—a repetition of the Kremlin's military and humanitarian aggression—will be high even shortly. To avoid such risks, it is necessary to achieve a complete reformatting of the government and structure of the Russian state, depriving it of its main levers of influence in the international arena, directing the primary vector of its policy inward, and facilitating the formation of new independent states on its territory.

Conclusions

Strong negative trends have characterized Ukraine's demographic development over the past 30 years. The analysis of demographic sustainability showed its critical and threatening state in Ukraine and its regions in the pre-war period. The significant population decline is mainly caused by decreased birth rates, constantly high mortality rates, and labor migration.

The state of demographic reproduction in Ukraine was in crisis from 1992 to 2010. After some improvement in 2011–2020 (demographic reproduction index of 0.709–0.750), it deteriorated in 2021. The EU-27 is generally characterized by a better state of demographic reproduction, especially regarding life expectancy and working-age mortality.

The age balance of Ukraine's population has deteriorated. The aging of the population had a constant trend, although Ukraine's population was generally younger than that of the EU-27. The sex structure of the population in reproductive age was balanced before the invasion, but now it gets worse due to hostilities and forced migration. The general age-sex balance index has deteriorated significantly since 2011, approaching a threatening state in 2021.

A large-scale war catastrophically aggravated the demographic crisis that existed in Ukraine before the Russian invasion due to the high risks of population decline and deterioration of demographic reproduction and age-sex balance. The prospects for further demographic development in Ukraine depend on the military-political and socioeconomic conditions. The rapid population decline predicted before the war is now inevitable.

In territorial terms, the war has exacerbated the differences in the demographic development of Ukrainian regions. Most regions that lost population during the war were already in a demographic crisis even before the full-scale invasion. Donetska and Luhanska oblasts with a large number of wholly destroyed towns and villages, regions of the eastern Polissia area with demographically depressed rural areas, and temporarily occupied parts of Khersonska and Zaporizka oblasts, which, along with other similar territories, have been the places from which Russia has been committing genocidal relocation of children and other crimes against humanity and war crimes for more than a year, are approaching the brink of a demographic catastrophe.

In the demographic sense, the expanded reproduction of the population is the condition for compensation for the demographic losses due to the deaths of military and civilian citizens of Ukraine and forced emigration. However, this is impossible now and in the short or medium term. Therefore, the rate of population decline should be gradually reduced in the early stages of post-war recovery. The high risks of non-return of a significant number of female migrants of reproductive age and children and the post-war migration of the male population abroad significantly limit such opportunities. The problems of the demographic revitalization of the occupied territories lie both in economic recovery and, to a large extent, in the socio-political and humanitarian spheres. After the emigration of Russian citizens and collaborators, to prevent future manifestations of separatism in the de-occupied territories, a clear pro-Ukrainian social and humanitarian policy should be implemented to return the population of these territories to the Ukrainian linguistic, educational, informational, cultural, and historical space.

The main tasks of improving the demographic sustainability of Ukraine and its regions include the return of Ukrainian migrants (first of all, addressing housing and employment issues) and the pronatalist policy of the state and its regions, focusing mainly on the model of three children in a family. Such a policy should include direct and indirect measures to support large families, primarily related to providing housing, employment, and adequate social and economic infrastructure. Another way to mitigate demographic losses is through selective immigration. Solving demographic problems requires a “demographic orientation” of state and regional post-war recovery strategies, which should contain provisions that directly or indirectly promote the return of Ukrainian migrants, increase the birth rate, and balance the demographic structures of regional societies.

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