International Institute for Applied Systems Analysis
IIASA www.iiasa.ac.at

Address: IIASA, Schlossplatz 1, A-2361 Laxenburg, Austria

Email: permissions@iiasa.ac.at

Working paper

Human capital futures in Eastern Europe and the Caucasus amid aging, depopulation, and high skilled emigration

Samir KC kc@iiasa.ac.at
Nicholas Gailey gailey@iiasa.ac.at

WP-23-003

Approved by:

Name Albert von Jaarsveld
Program: Director General and Chief Executive Officer
Date: 03 February 2023

Table of contents

ZVR 524808900

Disclaimer, IIASA funding acknowledgment, and copyright information:
IIASA Working Papers report on research carried out at IIASA and have received only limited review. Views or opinions expressed herein do not necessarily represent those of the institute, its National Member Organizations, or other organizations supporting the work.

The authors gratefully acknowledge funding from IIASA and the National Member Organizations that support the institute (The Austrian Academy of Sciences; The Brazilian Federal Agency for Support and Evaluation of Graduate Education (CAPES); The National Natural Science Foundation of China (NSFC); The Academy of Scientific Research and Technology (ASRT), Egypt; The Finnish Committee for IIASA; The Association for the Advancement of IIASA, Germany; The Technology Information, Forecasting and Assessment Council (TIFAC), India; The Indonesian National Committee for IIASA; The Iran National Science Foundation (INSF); The Israel Committee for IIASA; The Japan Committee for IIASA; The National Research Foundation of Korea (NRF); The Mexican National Committee for IIASA; The Research Council of Norway (RCN); The Russian Academy of Sciences (RAS); Ministry of Education, Science, Research and Sport, Slovakia; The National Research Foundation (NRF), South Africa; The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning (FORMAS); The Ukrainian Academy of Sciences; The Research Councils of the UK; The National Academy of Sciences (NAS), USA; The Vietnam Academy of Science and Technology (VAST).

Abstract

Eastern Europe is a demographic frontrunner among late-stage *Demographic Transition* societies. The feared consequences of its aging, brain drain, and depopulation have drawn major political attention in the region. To assess the inevitability of such trends, a new multi-dimensional demographic model projects the populations of Armenia, Georgia, North Macedonia, Romania, and Ukraine. A range of futures beyond a baseline scenario were investigated, reflecting emigration intentions and desired fertility. Findings suggest that from 2020 to 2050 the five populations would decline by 5%-36% and the proportion aged 65+ would increase by 48%-99%, but concurrently see a 7%-49% relative rise in skilled human capital (vocational or tertiary education) among those aged 20-64. Depending on whether policy succeeds in helping people achieve their desired fertility or lowering brain drain pressures, these potential outcomes can become considerably more moderate or magnified.

About the authors

Samir KC leads the Multidimensional Demographic Modeling Research Group at the International Institute for Applied Systems Analysis.
(Contact: kc@iiasa.ac.at)

Nicholas Gailey is a researcher at the International Institute for Applied Systems Analysis.
(Contact: gailey@iiasa.ac.at)

Authors contributed equally to this research.

Acknowledgments

This paper has been produced with support from the World Bank project, "International Migration in Europe and Central Asia: Evidence, Challenges and Policy Solutions" (P178378).

Human capital futures in Eastern Europe and the Caucasus amid aging, depopulation, and high skilled emigration

Introduction

Much of the broad Eastern European region is confronted with both the low fertility of high-income countries and the high emigration of medium-income countries since the socio-political upheavals of the early 1990s. This unique combination of trends has produced aging and shrinking populations. Governments of the region have acknowledged the situation with increasing urgency and dedicated resources to a variety of measures aimed at either coping with the consequences or attempting to reverse the trends. In 2020, Croatia's 6-month European Union presidency gave new prominence to the depopulation issue in Europe, with the Prime Minister labeling the prospect an "existential" risk (Fleming et al. 2019).

Such demographic change is – to some extent – natural or inevitable in industrialized societies where people live longer lives and have fewer children than in past centuries. Together with notable examples from East Asia like Japan and South Korea, many countries in Eastern Europe are at the forefront of new demographic frontiers in aging and depopulation currently emerging in late-stage *Demographic Transition* societies. However, these results of modern birth-death regimes are accelerated by, at times, large migrations westward. Perceptions of poor job prospects at home, inefficient labor markets and skills gaps in Western European countries, wage differences, and the ease of movement all facilitate high emigration rates. The Global Competitiveness Index shows that many countries of the region are among those least able to retain talent in the world (WEF 2017), while the IMF warns against broad declines in competitiveness and sinking GNI/capita despite remittances (Ruben et al. 2016). In recent years reporting has suggested that COVID-19-driven returns have reversed the longstanding net outflows from Eastern Europe (The Economist 2021), but it is too early to declare this as more than a temporary phenomenon since the basic pre-conditions for high emigration remain in place. In the case of Ukraine, the 2022 outbreak of conflict has already revived emigration on a massive scale (UNHCRa 2022).

The strengthening and activation of human capital have become even more critical as a realistic strategy for adapting to population aging and depopulation in Eastern Europe and the neighboring South Caucasus. For this reason, we consider how human capital will develop in a range of possible futures for five countries of the wider region: Armenia, Georgia, North Macedonia, Romania, and Ukraine. Human capital in this study is measured by educational attainment categories, broken down into lower secondary and less, upper secondary, technical training, and various levels of tertiary education to reflect the educational priorities and pathways in these five countries.

Comprehensive population projections are critical for national planning efforts, especially in countries with major demographic shifts in motion. Data limitations on migration and even large discrepancies in reported population size present additional challenges to establishing the current reality in many Eastern European countries. The results of this model – a Cohort-Based Multidimensional Demographic (CBMD) model –

represent new efforts to reconcile data discrepancies and include overlooked demographic variables to provide policy-oriented population projections for human capital in the region.

Demographic Scenarios:

The CBMD model is different from the period-based models, used by the Wittgenstein Centre (WIC), Eurostat, and the United Nations Population Division, which has the added advantage of being able to differentiate cohort-specific life expectancy, fertility, migration, and other variables as data become available. This is of interest to policy-makers because it is more user-friendly and allows for easy implementation of various what-if scenarios, defined by age, period, or birth-cohort; e.g., changing rates for a particular cohort (as implemented for Desired Fertility and Youth Exodus scenarios), for everyone during a period (COVID-19), or both during a specific period of time for a certain age-group(s) (e.g. new education reforms or a targeted fertility policy). In terms of output, we explore changes in population size, age structure, sex ratios, and education composition over the coming decades.

Middle-of-the-road assumptions on fertility, mortality, and migration were implemented in the baseline scenario to reflect recent trends. To establish or modify the base populations for Georgia and Ukraine, this paper uses estimates from their respective statistical offices, which both exclude disputed territories[1]. The projections begin in 2015 for Armenia, Georgia, and Romania, and 2020 for North Macedonia and Ukraine. A full account of the methods behind these projections can be found in the Supplementary Materials.

Special Case – Ukraine Baseline 1 and 2: Two different baseline scenarios were produced for Ukraine given important data discrepancies that complicate efforts to establish current demographic realities, especially on the country's population size and migration flows. An additional complication is how to treat the sizeable population of refugees, who may or may not return in large numbers over the coming years.

In Baseline 1 migration was taken from UN stock data and 80% of the ~4 million Ukrainian refugees (who left in the first 2-months of the 2022 war) are assumed to return by 2030. In Baseline 2 migration was taken from Ukrainian Border Crossings data and 25% of the ~4 million Ukrainian refugees (who left in the first 2-months of the 2022 war) are assumed to return by 2030. See Supplementary Materials for further details.

Using the CBMD model, three alternative scenarios (explained below) for each of the five countries studied were constructed to explore broadly different policy goals and the extent to which the baseline trajectories can in fact be altered.

Youth Exodus: In this scenario young people (ages 18-29) were projected to emigrate based on the desires they express in surveys [2]: Armenia (50.8%), Georgia (39.4%), North Macedonia (59.5%), Romania (68.4% / 65.5% / 52.7%, cohort specific), and Ukraine (60%). These extremely high rates capture a desire or plan,

[1] Projections in this study use population data from Georgia's GEOSTAT (which excludes Abkhazia and South Ossetia) and Ukraine's UKRSTAT (which excludes the Autonomous Republic of Crimea and city of Sevastopol).
[2] The implementation and the source of country-specific data is detailed in the Supplementary Materials.

which is very different from those who realize their emigration intentions. Nevertheless, if policies were to further facilitate the realization of even half of these potential movers, the demographic consequences would be severe. This scenario is meant to gauge the range of potential demographic implications if youth emigration accelerates. Other recent trends (fertility, mortality, education) were kept constant, and immigration is proportionally increased by 40% to account for returnees, using an estimated rate for Eastern EU countries between 2011-16 (Vercauteren 2019).

Outflows Reduced: In this scenario a mixture of less attractive opportunities in the typical destination countries and better prospects at home bring net migration in line with the global average for upper middle-income countries. This is done using a 75% reduction in emigration and then immigration was adjusted accordingly to fit with the UN's projected net migration five-year averages between 2015 and 2050, with the rate of -0.327 per 1000 people for 2020-2025 (UN 2019). The UN's projected rates for the lower middle-income country grouping were used for Ukraine, starting with -0.549 per 1000 people for 2020-2025 (2019).

The trigger for this new moderation in emigration could be the disruptions to economies and movement due to COVID-19. Sizable COVID-driven returns have reversed old East-to-West migration patterns across Eastern Europe, at least in the short-term. Many governments in the region hope such returns will be an opportunity to reintegrate these largely working age populations into the local labor force. Germany, one of the largest receivers of migrants from the region, also indicated reluctance to continue a large-scale recruiting program in the Balkans signaling a policy change from previously recruiting from the region in favor of reduced outflows from non-Schengen countries in Europe (Deutsche Welle 2018; 2020).

Desired Fertility: In this scenario, family support policies were implemented and succeed in helping people reach the family sizes they reportedly desire. The actual number of children had by couples in Armenia, Georgia, North Macedonia, Romania and Ukraine (and many other countries in the region) is consistently below what people express as their ideal in surveys due to a variety of competing interests and barriers, prominently economic worries. Such a change to the desired number of children would bring fertility near, or in some cases well above, replacement level (2.1 children per woman). Table 1 shows the desired fertility implemented in this alternative scenario, starting with the cohort aged 15-19 in 2015. For older cohorts, fertility rates for the remaining ages were adjusted accordingly.

Table 1. Desired vs. Baseline Fertility Estimates.

	Average Desired Number of Children[3]	WIC Estimated Fertility, 2015-20 (Lutz et al. 2018)
Armenia	2.4-2.8 (cohort-specific)	1.43
Georgia	2.8	1.78
North Macedonia	2.61	1.40
Romania	1.87-1.94 (cohort-specific)	1.48
Ukraine	2.0	1.38

[3] The implementation of country-specific data is detailed in the Supplementary Materials.

Results:

Depopulation and Aging

In this section the results explore a variety of possible demographic futures under different conditions in Armenia, Georgia, North Macedonia, Romania and Ukraine. By 2050, each of the five countries are expected to have smaller populations compared to 2020 in the baseline scenario, shown in Table 2. The declines over that course of time are as follows: Armenia(-5.2%), Georgia (-8.7%), North Macedonia (-35.6%), Romania (-19.9%), and Ukraine (-21.1% to -34.4%). Compared to the UN projections, the CBMD model results presented here demonstrate a similar-to-slightly more moderate outlook for change in population size in the Caucasus (Armenia and Georgia), while the declines in North Macedonia, Romania, and Ukraine appear to be deeper. Without considering updated current population estimates, updated emigration rates, or differentials in emigration by education, the UN projections estimate the following 2020-2050 decreases: Armenia (-5%), Georgia (-11.8%), North Macedonia (-10.8%), Romania (-15.5%), and Ukraine (-19.5%).

Table 2. Projected Population Size (millions) and Population Aging (% of population 65+), Baseline Scenario in 2020 and 2050.

	Population (mil), 2020	Population (mil), 2050	Prop. 65+ (%), 2020	Prop. 65+ (%), 2050
Armenia	2.9	2.8	12.5	24.8
Georgia	3.7	3.4	15.1	22.4
N. Macedonia	1.8	1.2	17.2	28.7
Romania	19.4	15.5	19.8	29.4
Ukraine-1	41.6	32.8	17.3	29.1
Ukraine-2	41.6	27.3	17.3	28.9

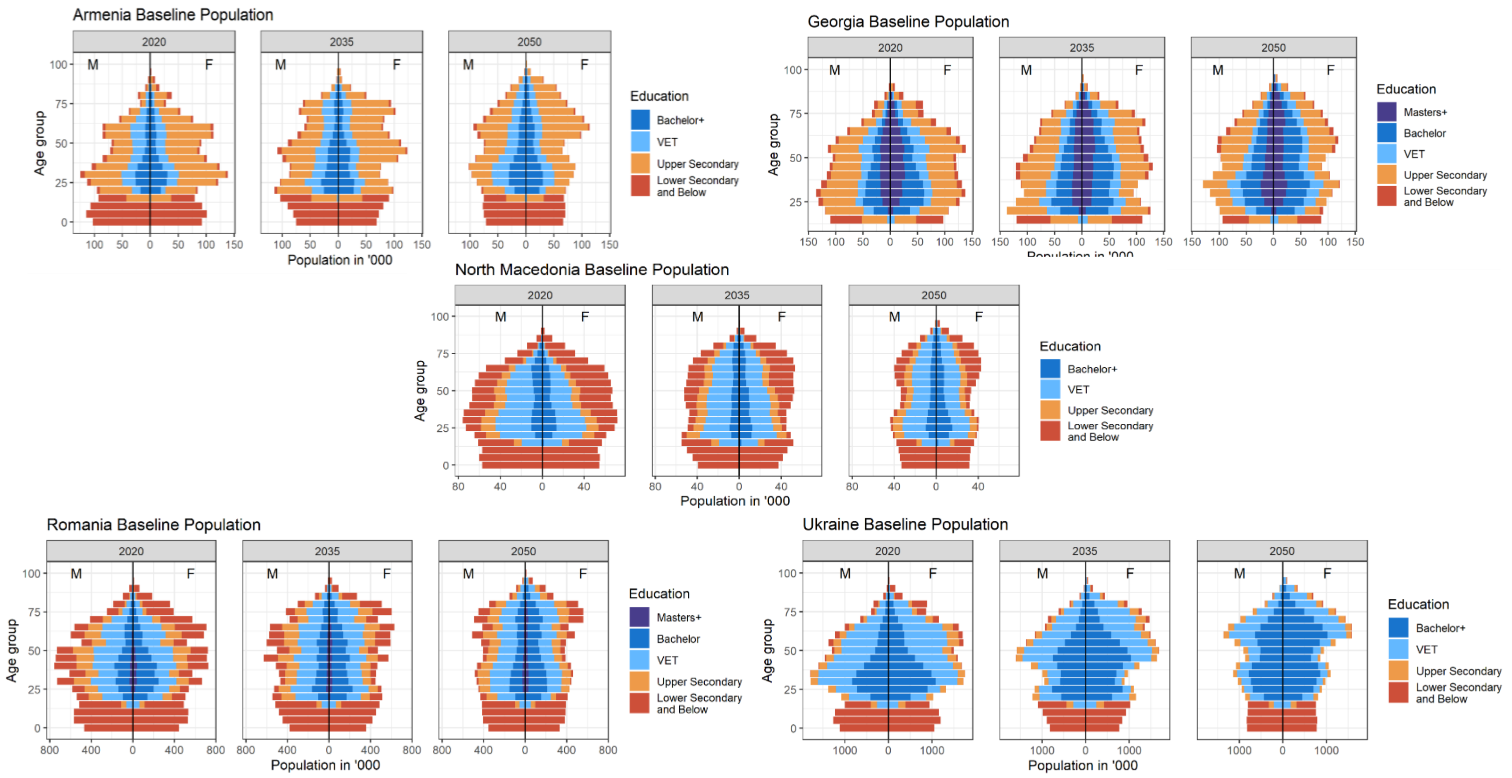
** The 2020 value for North Macedonia is projected based on 2021 Census results.*

Between the two alternative scenarios working against these depopulation trends – Outflows Reduced and Desired Fertility – the decline is more limited when fertility increases to desired levels for all of the countries, except North Macedonia, where a reduction in emigration makes a larger impact. Some of the strongest reversals by 2050 are seen in Georgia and Armenia, where populations are nearly stable (-4.3% and -3.8% with Outflows Reduced) or even growing (+20.6% and +13.3% with Desired Fertility) relative to 2020.
On the other hand, the scale of population loss would be unprecedented and extreme in a Youth Exodus scenario where emigration reaches levels of intentions expressed in surveys. The steep decline in which the young cohorts are nearly cut in half by the time they reach their early-30s would rapidly accelerate the demographic trends already in motion. Already by 2050 in such a scenario, the depopulation would range from a minimum of -25.1% in Armenia to a maximum of -46.3% in North Macedonia, with the others at: Georgia (28%), Romania (-40.4%), and Ukraine (-38.8% to -47.4%). The purpose of this scenario is not to present a likely scenario, but rather to demonstrate the extent of latent demographic downturns if policies further facilitate potential emigration.

The widespread phenomenon of populations getting older is also projected to carry on in the countries studied, as seen in Table 2. The following increases in the proportion of the population aged 65+ are projected in the baseline scenario from 2020 to 2050: Armenia (99%), Georgia (48%), North Macedonia (67.3%), Romania (48.6%), and Ukraine (67.2% to 68.3%). In spite of the relatively quick pace of aging, populations in the post-socialist countries of Eastern Europe and the Caucasus still remain younger than their counterparts in Western and Southern Europe. For comparison with the projection results shown in Table 2 – which show the proportions aged 65+ in the mid-to-upper 20s by 2050 – those same proportions are expected to reach 30% in Western Europe and 36% in Southern Europe by 2050, increases of 40.2% and 64.3% from 2020 respectively (Lutz et al. 2018). This is due in part to demographic momentum from higher birth rates in the decades preceding the 1990s as well as lower life expectancies, both gaps which have been reducing between the former East Bloc countries and the rest of Europe.

Below (Figure 1) is a set of population pyramids by age, sex, and educational attainment. The model used in this study implements the Wittgenstein Centre's assumptions for progression of educational attainment, which expects continuation of the present trend in the country, guided by regional and global pathways. For the countries covered in this study this means only modest growth past current high levels of educational attainment among the subsequent young cohorts. The baseline educational distributions and treatment of education transitions are detailed in the Supplementary Materials. Primarily due to the higher propensity of younger cohorts to attain tertiary education, and the gradual replacement of generations through a process referred to as Demographic Metabolism, the populations become more educated over time in each of the five countries.

Fig. 1. Populations by Age, Sex, and Education, 2020-2035-2050, Baseline Scenario.



** The VET category includes vocational and technical education, the majority of which is attained at the upper secondary level in the countries above.*

Refined Perspectives on Workers and 'Working Age Populations'

Population aging and depopulation has driven fears about a declining labor force, in particular a severe worsening of old-age dependency. However, the conventional measure of dependency relies on crude assumptions – everyone ages 20-64 are productive workers, and those 0-19 and 65+ are dependents. There is growing agreement among experts that this is a misleading demographic indicator for determining economic vitality. The solely age-based concept of dependency misses important changes in the nature of aging that are making age 65 an arbitrary and unsustainable cutoff for productive working life (Sanderson & Scherbov 2008; 2010). Using Sanderson and Scherbov's Prospective Aging measure (the proportion of population with a remaining life expectancy below 15 years), the future of aging in all five of the countries studied seems less dramatic compared to conventional, easy-to-misinterpret measures. In terms of the redefined aging measure, the results can be seen in Table 3. Critically, the refined perspective approximately cuts in half the level of potential burden that the equivalent 65+ metric otherwise indicates – a much more manageable prospect.

Table 3. Prospective Aging (Proportion of Pop with Remaining Life Expectancy of 15yrs or Less) vs. Proportion of Pop 65+

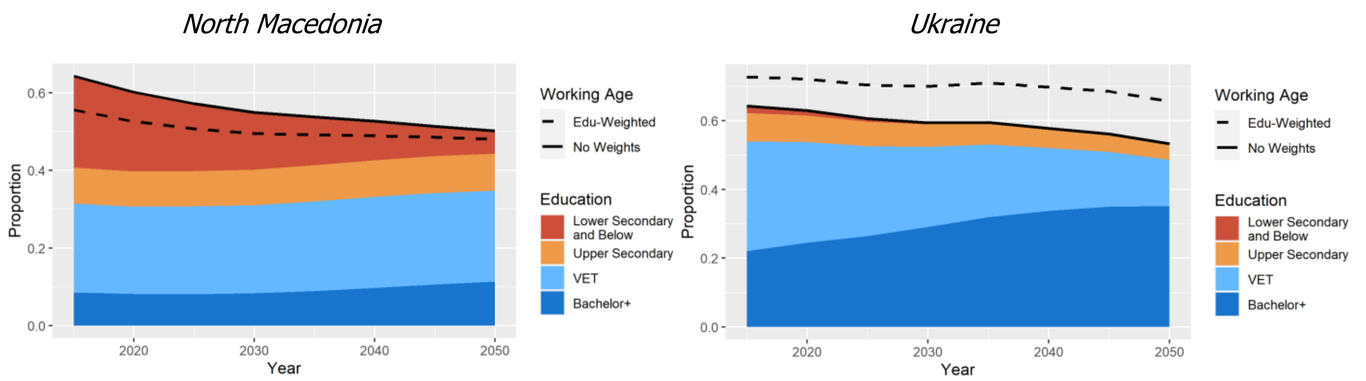
	Prospective Aging (%), 2020	Prospective Aging (%), 2050	Prop. of Pop 65+ (%), 2020	Prop. of Pop 65+ (%), 2050
Armenia	7.6	12.9	12.5	24.8
Georgia	11.1	12.2	15.1	22.4
N. Macedonia	11.9	16.9	17.2	28.7
Romania	12.3	17.3	19.8	29.4
Ukraine-1	13.2	16.4	17.3	29.1
Ukraine-2	13.2	16.7	17.3	28.9

Besides redefining when working life begins and ends, it is also important to recognize how accounting for human capital in the conventional working age population can alter outlooks on the future (Brunello & Rocco 2015). The share of the population aged 20-64 with VET or tertiary education is projected to grow (in proportion to those with lower educational attainment) between 2020 and 2050 by the following: Armenia (35.4%), Georgia (32%), North Macedonia (36%), Romania (49.2%), and Ukraine (6.9% to 12.6%). Such growth in VET and tertiary education suggests better future labor force outcomes and greater productivity (Lutz 2011). Critically, these human capital gains are also in absolute terms for Armenia, Georgia, and Romania, whereas North Macedonia and Ukraine see their total numbers of people with skilled human capital decline since the speed of educational attainment expansion fails to compensate for emigration and low fertility.

Figure 2 shows the conventionally-defined working age population by education attainment. The total working age population (solid black line) is meant to be contrasted with a productivity-weighted adjustment (dashed line), which assesses the working age population in terms of its component educational attainment groups. This is done by applying the observed average income by education, a proxy for productivity. The relative returns in the countries studied were calculated according to country-specific data (detailed in the

Supplementary Materials), which all follow a general pattern. When the average earnings of people with upper secondary education in the countries studied is set to 1 for reference, those with university education earn about 1.3 and those with lower secondary and below earn approximately 0.8 by comparison. In the countries studied the returns to VET are very similar to upper secondary earnings, similar to general findings by the OECD (Barişik & Budak 2020), although an employability benefit often exists for VET graduates.

Fig. 2. Working-Age Population (20-64) as a Proportion of the Total Population by Educational Attainment, Baseline Scenario, 2015-2050.



Relative returns to education can change over time and this productivity-adjusted measure does not incorporate other likely labor-relevant advancements such as technological, which could further aid in a population's overall productive and adaptive capacities. Furthermore, these figures are not meant for direct comparison with each other due to differing standards of productivity and wages.

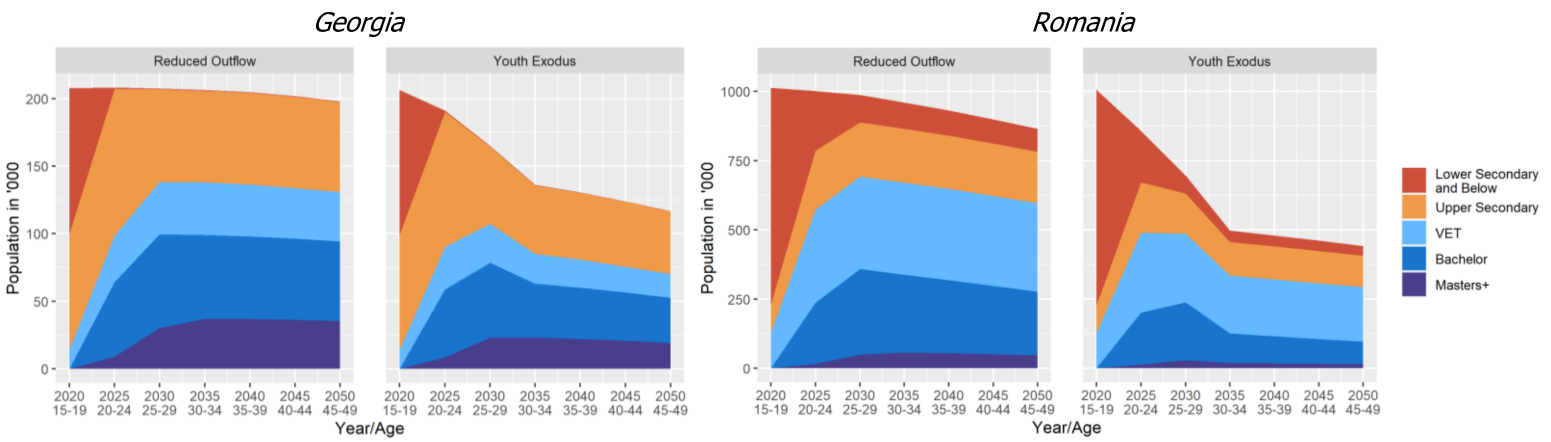
The productivity-weighted measure indicates that North Macedonia's conventionally-defined working age population is underperforming (as the dashed line can be seen below the solid line), although the gap decreases over the decades. In spite of the falling proportion of working age people in the population, the overall productive capacity is seen to remain relatively stable over time. On the other hand, Ukraine's productivity-weighted working age population can be seen to already outperform its size at the start of the projection. The productive potential declines over time, but less steeply than the decline in the simple working age population. Similar patterns are seen in Georgia and Romania. Armenia's productivity-weighted working age populations closely follow the working age populations' trajectory due to a smaller jump in educational attainment from the current old and young generations.

Scenarios of Human Capital Flight, 'Brain Drain'

The results below contrast the effects of emigration in the baseline (recent trends) scenario with those in the two alternative migration scenarios, which follow the extreme ends of contrasting policy goals. Emigration in the recent past has reshaped the region and created some of the largest proportional diasporas in the world, representing a critical undermining of human capital in the sending countries (Ruben et al. 2016). While brain drain can be defined more generally to encompass all those of working age or more narrowly to cover only critical professions, here we focus on the highly educated, conventional working-age population. In the baseline scenario projections, the accumulated (2020-2050) net migration of skilled human capital (VET and tertiary educated) among working-age (20-64) adults (expressed as a proportion of the equivalent working age population in 2050) amount to the following losses: Armenia (-35.1%), Georgia (-14.3%), North Macedonia (-58.8%), Romania (-35.3%), and Ukraine (-4.9% to -33.7%). The large variation in Ukraine's brain drain values is due to the different migration rates implemented, UN vs State Migration Service, paired with contrasting assumptions about refugee return rates.

Figure 3 shows the evolution of the Georgian and Romanian age-cohorts born in 2000-2005, most of whom will still be in the process of completing their education into the late-2020s. The Outflows Reduced scenario presents a future where still more people are leaving than returning, but the rate reduces to the average levels of the upper middle-income countries. A scenario of moderate emigration would aid in the gradual accumulation of the countries' highly skilled human capital, where the expansion of educational attainment strongly overtakes the outflow of highly educated people. As indicated in the figure, the clear majority of the cohorts remain intact. Compared to the accumulated brain drain measure used in the paragraph above, this scenario only produces the following losses: Armenia (-8.1%), Georgia (-2.2%), North Macedonia (-4.4%), Romania (-7.8%), and Ukraine (-1.5% to -10.1%).

Fig. 3. Birth Cohorts 2000-05, Youth Exodus vs. Outflows Reduced Scenarios.



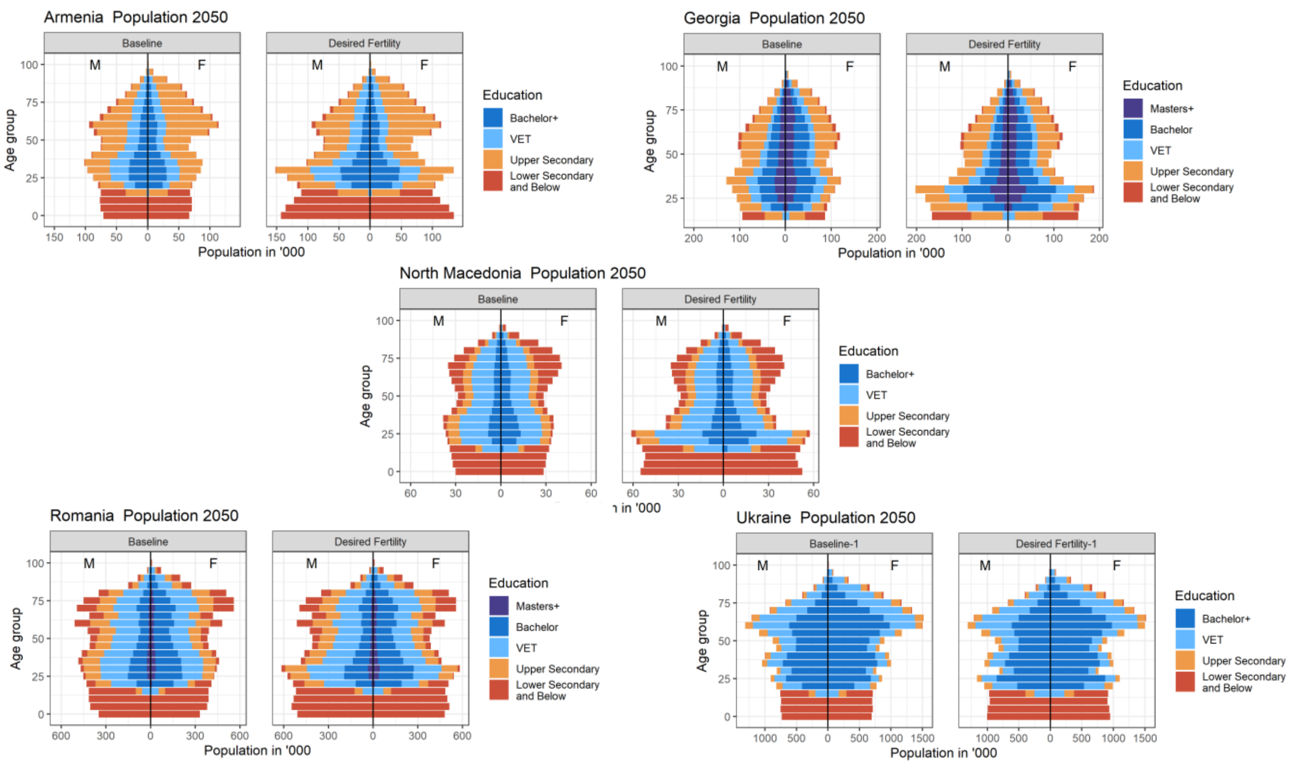
The Youth Exodus scenario – also in Figure 3 – shows a future where young people (18-29) leave their countries at the very high rates expressed in surveys and return according to estimated averages for the Eastern EU member states. If emigration was further facilitated by policies to actualize these potential movers, who express primarily economic motivations of employment and higher wages, there would be a severe drop in total human capital. Furthermore, the strength of the outflows would even reverse relative educational gains among the overall population in Romania. In terms of the conventionally-defined working age populations, this scenario would mean debilitating accumulated losses of those with VET or tertiary education over the period 2020-2050, relative to the 2050 population with the same educational attainment: Armenia (-105.5%), Georgia (-57.2%), North Macedonia (-95.4%), Romania (-112%), and Ukraine (-37.6% to -70.5%). The rapid shrinking of childbearing cohorts would also bring delayed impacts that become evident decades later in birth patterns, and eventually in levels of human capital.

Influence of Fertility on Young Populations

The most common policy response of governments to current demographic trends is the aim to restore birth rates to above replacement level. In keeping with the work of the Wittgenstein Centre, the baseline fertility is assumed to preserve differences by education, where more education is associated with later births and overall lower fertility. Low fertility and its delayed age structure effects of smaller cohorts (especially from the 1990s) are responsible for the declines in the baseline scenario youth population (0-29) from 2020-2050 to the following degrees: Armenia (64.4%), Georgia (94.8%), Romania (9.8%), North Macedonia (40.2%), and Ukraine (60.8% to 82.6%). The rest of the decline comes directly from emigration and indirectly from removing would-be mothers from the population. Due to its relatively young age structure, Armenia's fertility of 1.68-1.69 is still enough to very slightly grow the total population by 2050 in the absence of migration (the fertility-driven decline would show up in later decades). In Georgia, there appears to be a successful fertility rebound underway since the mid-2010s, suggesting rare potential for stabilizing around replacement level – which if maintained will reflect in the whole population in the long-run.

A scenario where an effective mix of policy support for parents is successful in helping couples achieve their desired fertility would bring a reversal of population declines in Armenia and Georgia, and the five countries studied would see significant absolute jumps (30%-101%) in their young populations compared to the 2050 baseline. As seen in Figure 4, the Desired Fertility scenario results in a return to the traditional pyramid shape from which the population pyramid takes its name. Nevertheless, the proportion of the population aged 65+ still rises in Armenia to 66.6%, Georgia (12%), North Macedonia (37.5%), Romania (35.6%), and Ukraine (53.6% to 55.2%) from 2020-2050, highlighting how population aging is essentially inevitable.

Fig. 4. Population Composition, Baseline vs. Desired Fertility Scenarios in 2050.



Policy Implications:

The baseline projections foresee smaller, older, and better educated future populations in the five countries studied. Such prospects are in line with the broad trends in most industrialized countries after decades of rapid growth in the earlier stages of the *Demographic Transition* (a near-universal pattern of development). Distinct to Eastern European and the Caucasus however – with the countries in this study as no exception – is the extra role that the outflows of people, especially to Western Europe, play in lowering population size and speeding population aging.

Within certain bounds, population aging and decline do not necessarily equate to general societal decline. To some extent these trends are even symptoms of medical and economic successes. Regardless of the causes and implications, population aging in particular is largely resistant to policy interventions (Lutz et al. 2019). The most serious of the commonly feared consequences of such demographic trends is an unfavorable breakdown in the balance between workers and dependents, a reality that may in fact not even materialize. In Europe, the near-equal advances in Life Expectancy at 60 and Healthy Life Expectancy at 60 (WHO 2020), and expansion of educational attainment, highlight how a population's composition is not constant and numbers alone are not a meaningful policy objective. If the goal is to maintain a balance of workers and dependents, efforts should be oriented toward cultivating the productive capacity of a population as well as limiting negative societal pressures that make it more difficult to establish working lives and families.

A Vision for Human Capital Management

For the countries covered by this study, a coherent human capital management strategy can be summarized by the following:

1) Ensure education is relevant and provides a clear pathway to working life
2) Incentivize greater labor force participation
3) Reduce barriers for people to achieve their desired fertility
4) Reach a consensus on migration and the competition for talent in Europe

Eastern European emigration is increasingly recognized as a force undermining prospects for development by various bodies, including the EU’s European Committee of the Regions (Boc 2020). As explored by the Youth Exodus and Outflows Reduced scenarios, the number of people who will take their talents and human capital elsewhere between 2020 and 2050 is a vital question. This topic of growing concern warrants the attention not only of national politicians in the countries concerned, but neighboring states, especially amid continuing pull-factors in Western Europe and the stated long-term political goals of EU membership. Hopes of higher living standards elsewhere and better job prospects are consistently the main motivations to leave (Ruben et al. 2016; OECD 2019; Sandu et al. 2014). Young people in countries with underdeveloped work-based education routinely have a lower employment premium and face more difficulties in labor market integration (Cedefop 2013).

Lifting labor force participation rates has the power to completely overcome the potential worsening of the ratio between workers and dependents for many European countries. Work by the European Commission

(Lutz et al. 2019) confirms this reality using the labor participation of Sweden today as a standard of convergence over the coming decades, where around 65% of the 15+ population were active as of 2021 (ILO 2022). For the countries in this study, the equivalent rates stood at the following: Armenia (52%), Georgia (59%), North Macedonia (53%), Romania (52%), and Ukraine (55%)(2022). This range is roughly in line with the Balkan countries and France (56%), above Italy (48%), but below others including post-Communist eastern peers like the Visegrád countries (57-60%), Russia (61%), and the Baltic states (60-63%)(2022). Scandinavian countries have reached new highs in terms of labor participation in Europe due in part to earned income tax credits, pension reform, and other policies aimed at incentivizing work.

Central and Eastern European countries tend to perform relatively well when it comes to training their populations for the labor market compared to the South or West according to the EU's European Skills Index (Cedefop 2022). In spite of the favorable performances in the wider region, many studies find inadequate quality of education in Armenia, Georgia, North Macedonia, Romania, and Ukraine. In North Macedonia for example the European Training Foundation finds, "high and persistent mismatches" and "a relative deterioration in the position of tertiary-educated workers as a result of a large increase in the supply of such workers, an over-education phenomenon that is more prevalent than under-education" (ETF 2020). In terms of the situation by cohort, the mismatch problem appears to be somewhat better for younger workers between the ages of 20 and 29. To avoid further losses and offer individuals credible prospects of integrating into the labor market, the private sector would need to be formally included in shaping programs (vocational, tertiary, and lifelong learning) in the spirit of dual education systems.

Economy-education disconnects are especially notable in vocational training, an education type with which many of the current (and expected future) skill shortages could be remedied. Confirming this reality, an assessment by the European Commission found that VET in Romania, "remains a second-choice option and in most cases is not adapted to labour market needs'' (EC 2018). The longstanding tradition of apprenticeship learning (ucenicia lalocul de munca) nearly disappeared during the transition period of the 1990s, but more recent efforts have been made to revive a similar system (Cedefop 2019; 2016). More generally, greater cultural acceptance for VET would help countries to counteract skills obsolescence and adapt to the artificial intelligence disruptions (Cedefop 2018). Expanding the higher-tier post-secondary non-tertiary VET is seen as one way to raise the social status of applied education.

Besides doing more with fewer people – by improving education and labor participation – the barriers to starting new families should be limited if the goal is to maintain a stable and balanced population in the long-term. Many of the same quality of life concerns that motivate emigration also make it harder to realize desired fertility as it is connected to stability and confidence in the future. Scandinavia, the German-speaking countries, and more recently others in Central Europe have implemented a variety of pro-natal measures to this end: strengthened parental leave, kindergarten expansions for working parents, tax benefits and other approaches. In general, fertility measures focused on alleviating work-life pressures are more effective than direct cash transfers (Sobotka et al. 2019).

The countries of this study have seen strong growth in GDP over the last 10 years, but if Western Europe is used as the point of comparison, economic convergence is still seemingly far off. Amid economic hardship, decisions to leave a country or start a family both require a certain degree of confidence in the future. Many of these concerns are directly and inevitably linked to decisions within a national government's control, however the countries studied do not exist in a vacuum as they are also heavily influenced by the most advanced economies of Europe and their migration incentivizing pull-factors. Even though solidarity is a guiding principle of contemporary intra-European relations, no coherent consensus has been reached on best practices when it comes to the ongoing competition for talent in Europe. Until key Western European countries successfully address their own skill shortages with educational reforms – particularly in critical fields like medicine and trades – they are set to continue passing on demographic and human capital externalities to their eastern neighborhood.

Supplementary Materials:

The methods used in this paper are explained in detail by first describing the model in general and then the specific treatment of various factors in particular.

We defined a multidimensional population projection model for each country. We consider three critical dimensions: age, sex, and education. The age dimension is divided into 20 five-yearly cohorts (***A:*** aged 0-4, 5-9, …, 95-99) and a final open-ended age 100 and older (100+). For each birth cohort (***C***), identified by the time of birth (***tob:*** e.g. 2010-2015 birth cohort are aged 0-4 in 2015), we further define sub-groups by sex (***S:*** male and female) and educational attainment (***E***: e1: <= Lower Secondary, e2: Upper Secondary, e3: Non-tertiary Post-Secondary, e4: Bachelor degree, and e5: Masters and PhDs). All together any individual in a country at a given time will be in one of the 210 states (21 ***A***ge-groups x 2 ***S***exes x 5 ***E***ducation categories) in the three dimensions (***ASE).*** Population distributions by age, sex, and educational attainment at the start of the projection period (2015) were extracted from the Wittgenstein Centre (WIC) projections (KC et al. 2018) that uses age and sex distribution for 2015 from the UN's World Population Prospects 2017 (UN 2017). These were then corrected according to newer data (when possible), with the country-specific modifications detailed in the subsequent sections of this Supplementary Materials section. WIC's assumptions of future demographic developments in age-, sex-, and education-specific fertility and mortality as well as the educational attainment transitions were implemented to produce the projections.

Steps of the Projection:

1. pop * sx
2. (pop * sx) * (edutran)
3. (pop * sx * edutran) * (1+imrate-emrate)
4. Births = pop_avg * asfr;
5. Popm_newcohort = births * sexr * sx

Over time individuals can change their state either deterministically (aging) or stochastically (education transitions), while other characteristics remain unchanged (sex). The model includes events both depleting (death and emigration; "sx" and "emrate") and increasing (immigration; "imrate") a cohort's size, and an event (birth) creating new cohorts according to age-specific fertility rates ("asfr"). Projection starts with July 1st, 2015 (besides Ukraine and North Macedonia, July 1st, 2020), and ends in 2050 in a five-year step, also called a time-step. The transitions for each event were defined in the following steps.

Baseline Population Size and Age/Sex Composition:

The base population size as well as age- and sex-structures for Armenia and Romania was taken from the UN's World Population Prospects 2019 (UN 2019). For countries with national statistics based on old census data and likely significant discrepancies between the official numbers and current number of people in the country, the model instead used alternative data to reflect the real situation as best as possible. Below is an overview of alterations made in this study to the Wittgenstein Centre's base population sizes and compositions (Lutz et al. 2018), with the purpose of better reflecting current demographic realities not captured by outdated or incomplete data.

Important Country Notes

Georgia: Geostat data (2022) was used to correct WIC's age-sex distribution for the 2015 population.

North Macedonia: The 2021 Census from North Macedonia's State Statistical Office (2022) was used to update the 2020 population size as well as age and sex distributions, since the previous estimates were outdated and showed large discrepancies as they relied on the last observed count in 2002.

Ukraine: State Statistics Service of Ukraine (2021; 2022) were used to update the population size, as well as the distribution by age and sex for mid-2020 (using 2020 and 2021 data).

Educational Attainment:

In this CMDM model five main education categories were covered. The lowest attainment categories used by WIC were merged into a category called e1 (at least lower secondary), followed then by e2 (upper secondary), e3 (post-secondary non-tertiary), e4 (bachelor), and e5 (master+). For only two countries (Georgia and Romania), the model uses WIC data covering all five of the outlined education categories. For Armenia, North Macedonia, and Ukraine we have WIC data for three education groups, with the highest education e3 grouping all levels of post-secondary tertiary education into "bachelor+".

Initial educational attainment distributions for the populations (besides Ukraine, explanation below) were interpolated from the Wittgenstein Centre (Lutz et al. 2018). For those countries, the additional step of splitting the commonly aggregated VET and secondary educational attainment categories in each of the countries, it was done according to the availability of age/sex-specific distributions. Profession-focused VET education was distinguished from other categories (upper secondary and post-secondary) because it represents a path that many governments want to popularize and a qualitatively different approach to education.

Important Country Notes

Armenia: Four education categories from WIC, with the upper secondary category split into VET and regular according to DHS data from Armenia's National Statistics Service (2017).

Georgia: Five education categories from WIC, with the upper secondary category split into VET and regular after the projection according to the Geostat Labour Force Survey (2021).

North Macedonia: Four education categories from WIC, with the upper secondary category split into VET and regular after the projection according to estimates by the Vienna Institute for International Economic Studies (Leitner 2021).

Romania: Five education categories from WIC, with the upper secondary category split into VET and regular after the projection according to estimates by the European Commission (2018).

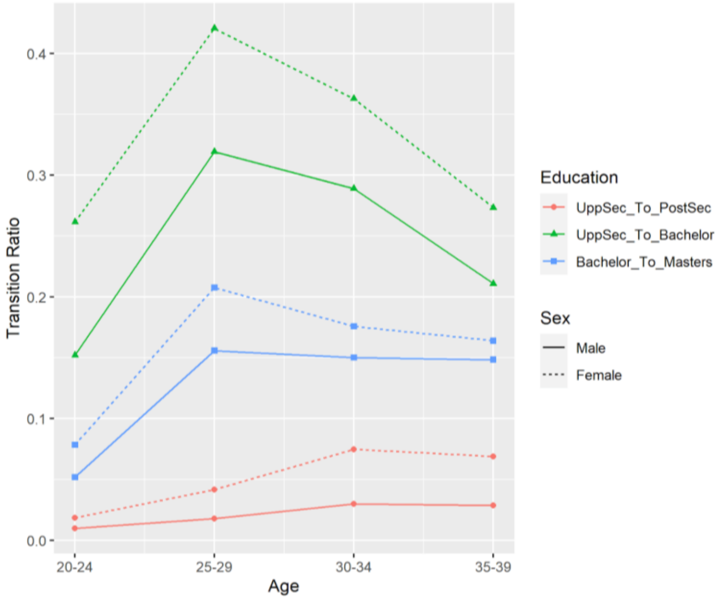
Ukraine: Four education categories; the Ukrainian population's educational attainment composition was synthesized based on WIC for older cohorts and Libanova et al. (2016) for the young and future population. This was done to account for the significant rise in tertiary education in the time since the last full census in 2001. For the VET category, upper secondary is split into VET and regular according to the same school-to-work transition surveys produced by the ILO (2016).

In terms of updating other demographic variables, the ultimately canceled Ukrainian electronic census conducted in 2019 showed a total population that was roughly in line with expectations, (37.29 million people as of December 1), excluding the Crimea and the Donbass regions. Experts argued the process was not reliable and represented a population count rather than a traditional census as it did not cover many of the usual demographic variables (Chukhnova 2020). Data remains inconsistent for those reasons, necessitating use of the multiple sources referenced.

Education Transitions:

Education-specific transition rates by age and sex determine the number of progressions to the next higher level of educational attainment during the time-step. We assume that the education transition stops after the cohort reaches age 30-34. The WIC database provides proportions (KC et al. 2018) and not transitions. Using the assumptions, we calculated the education progression ratios from each education group for each cohort starting at age 10-14 until age 30-34 for the projection period. Having transition ratios (example of Romania shown in Fig. S1) allows us to define alternative scenarios much easier than using proportions because education distribution is a result of the transitions and making changes at the root level (transitions) is more comprehensible and provides more concurrency to policy variables such as completion ratios, dropout rates, etc.

Fig. S1. Romania, Educational transitions as of 2011, by age group.



Source: (Lutz et al. 2018) WIC, based on data from the Romania Census 2011

Estimating education progression for each age-group: WIC projects education attainment for six levels of education categories (no education, some primary, primary, lower secondary, upper secondary, and post-secondary) at age 30-34 for each cohort that was used to calculate education progression ratio or the transition rates from each education level to the next one. Most of the education transitions occur during younger ages and were calculated by back-casting the cohort transitions using assumptions of progressions through ages. WIC assumes transitions to lower secondary are completed by age 20-24, for upper secondary and post-secondary it is 25-29 and 30-34 respectively. The assumptions are available as a proportional distribution of education by age and sex. For our purpose, using the proportion distribution, we computed transitions probabilities for each age. With the transition probabilities, we can easily define alternative scenarios. For a few countries [Georgia and Romania, here], WIC's post-secondary category was further divided into three categories: non-tertiary (which was combined into the larger VET category), first-level tertiary (bachelor), and second-level tertiary (master+). VET education, in terms of transition rates, was treated as upper secondary education. Examining WIC's data, the distribution of post-secondary (tertiary) into the two categories were held constant throughout the projection at the base-year (2015) level.

Mortality:

For the population aged 15 years and above, survival ratios for each group (by age, education and sex) determine the population surviving at the end of each 5-year time step and the survivors age an additional 5 years. For the population under 15 years old, survival ratios (in terms of the important education dimension) were defined by the mother's educational attainment. All mortality assumptions for the future (2015-2050) were extracted from the WIC database (KC et al. 2018).

Migration:

Emigration ratio for each group determines the number of people leaving the country during the time step, the denominator of which is the group size, including the emigrants, at the end of the time-step. The WIC's projections use migration flows that do not differentiate by education, a distinction which is being refined in our CBMD model. Hence, we estimated and defined a new set of assumptions in this report.

The migration rate used was adjusted according to UN stock data (UN 2022), which unlike UN migration flows data, is not tied to the after-the-fact balancing calculation for migration rates that is dependent on accurate fertility, mortality, and population size data to produce an accurate migration value.

Important Country Note

Ukraine: In the case of Ukraine two different migration rates were used given considerable discontinuities in migration data. The assumptions for the first baseline UA-1 (approximately net -110k over 5 years) come from changes in UN stock data (2015-20) which is not tied to the after the fact balancing calculation for migration rates that is dependent on accurate fertility, mortality, and population size data. The migration assumptions used for the second baseline, UA-2 are about 10x higher (approximately net -1,090,000 over 5 years), coming from State Border Guard Service of Ukraine data on border crossings of both Ukrainians and non-Ukrainians between 2013-17.

Both the baseline UA-1 and UA-2 scenarios modify the populations in the projection step of 2020-2025 to account for the significant refugee outflows following the outbreak of war in February 2022. Taking the outflows from the first two months (February 24 to April 24), 4,062,514 individuals were removed from the baseline population (UNHCR 2022a). Age and sex distributions were taken from estimates provided by the UN coving those entering Moldova (IOM/UN 2022), a major recipient and transit country for the refugees. Similar, less detailed data is documented about the flows to Poland (UNHCR 2022b). In terms of returnees, the UA-1 scenario assumes an 80% return rate by 2030 (3/4th return by 2025), based on polling responses (Razumkov Center 2022), while the UA-2 scenario assumes a much lower 25% return rate by 2030.

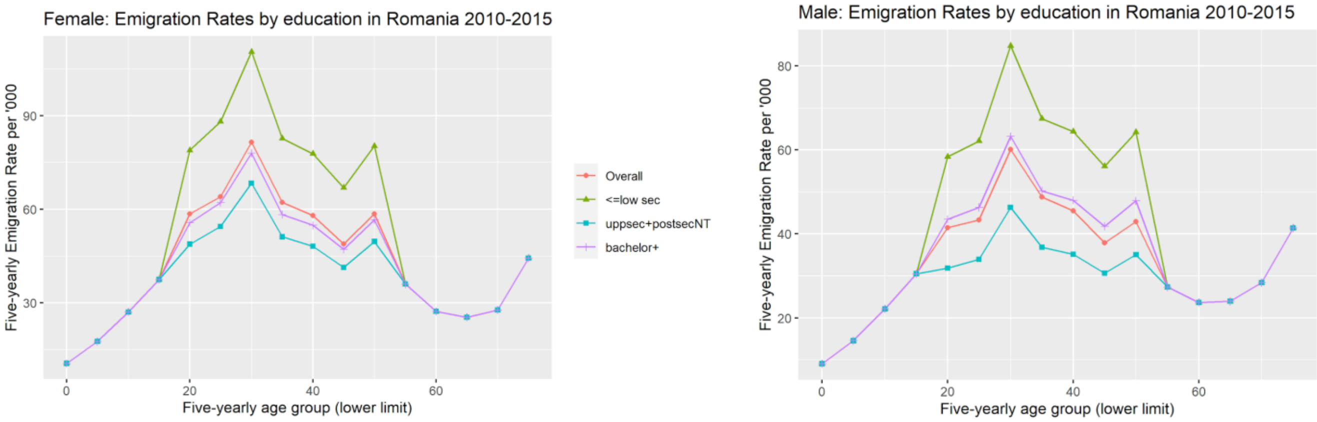
Education-, Age-, and Sex-specific Emigration

Age- and sex-specific migration rates were calculated using the age- and sex- specific migration flows from the work of Abel (2018), which uses UN migrant stock data (from the 2017 revision). Specifically, migration flows for the period 2010-2015 were divided by population from 2015 to calculate the rates. Only sex-specific total flows without age breakdown were reported in the 2018 paper, with the rest generated on request. These distributions reflect the general tendencies of migrants to be working-age in line with the standard Roger-Castro migration age-schedule (Rogers & Castro 1981).

These age- and sex-specific migration rates were then split by education – given the high prevalence (and therefore importance) of emigration in the region and variations in the self-selectivity of emigrants – using overall education-specific rates or proportions from the following studies: Armenia (Saavedra et al. 2019), Georgia (State Commission on Migration Issues 2017), Romania (OECD/WB 2022), and Ukraine (Luecke &

Saha 2019). North Macedonia is the only country in this study, which uses a distribution according to the general population’s educational attainment structure. The resulting age-, sex-, and education-specific migration flow rates were further revised with the most recent revision of UN migration stock data (2020), such that the overall sex-specific flows during 2015-2020 matches with the difference in the change in stocks of foreigners in country X and citizens of X abroad. The obtained adjustment factors were then applied to all future periods (shown in Fig. S2).

Fig. S2. Emigration rates of 5-yearly age groups, by education, during 2010-2015.



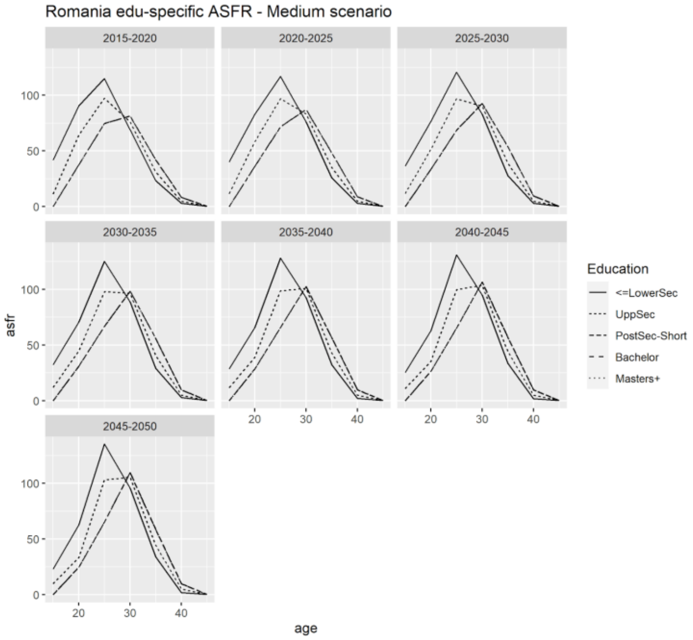
Immigration:

The immigration rate determines the number of people joining the group during the time step, the denominator of which is the group size at the end of the time-step. We use Abel’s estimates (2018) for immigration by age and sex, which have converted stock data to flows. We then use the education distribution of the country (destination) due to limited data.

Fertility:

The model uses age-specific fertility rates by educational attainment for women in reproductive ages 15-49 years. The total number of births is then split into males and females using the UN’s assumed sex-ratio at birth, males per female birth (UN 2017). Finally, sex-specific survival ratios by mother’s education were applied and a new cohort aged 0-4 is created at the end of the time-step. All assumptions were extracted from the WIC database (KC et al. 2018). Higher education is associated with later birth. Figure S3 shows the age-specific fertility rates implemented for Romania by different educational attainment levels.

Fig. S3. Age-specific fertility rates (ASFRs) by education in Romania.



Assumptions behind each Demographic Scenario:

Baseline

We start with a baseline scenario building on the WIC's (Shared Socioeconomic Pathways) SSP2 "middle-of-the-road" projected future. In terms of inputs, the main advancements are in the differentiated migration inputs by age, sex, and education and the associated assumptions about the future.

We assume, based on a very extensive consultation with experts done with WIC, that the life expectancy will tend to converge to a higher value (front-runner country) in the long run. Assumption for fertility is country-specific, for countries with low fertility, a long-term convergence by 2150 to a value of 1.75 children per woman is assumed. Further information on the reasoning behind these decisions has been documented at length in Chapter 2 of a report by Lutz et al. (2018) published by the European Commission and International Institute for Applied Systems Analysis (IIASA). The education-specific propensities to out-migrate were assumed constant, but the average educational attainment levels for subsequent cohorts were expected to increase (and may stabilize) following the trend (country, regional, and global).

Youth Exodus

The rates implemented for the ages 18-29 in the projections (shown in Table S1) were based on the survey results in the following studies: Armenia (ETF 2013), Georgia (2013), North Macedonia (Galevski 2019), Romania (Roman & Vasilescu 2016), and Ukraine (Drobchak et al. 2019; Mostovaya & Rohmanin 2017). Immigration is proportionally increased by 40%, with returnees coming back according to the following patterns: 20% within the next five years (1st 5yr step), 30% in the next 5yr step, 40% in the next, and finally 10%. For consistency emigration intentions were extrapolated to apply to ages 18-29 in each country and applied with age-specific variation according to data availability.

Table S1. Average emigration intentions, assumptions for the Youth Exodus scenario.

	Intentions to Emigrate among Youth
Armenia	Ages 18-29: 50.8%
Georgia	Ages 20-29: 39.4%
North Macedonia	Ages 15-35: 59.5%
Romania	Ages 15-19: 68.4% / Ages 20-24: 65.5% / Ages 25-29: 52.7%
Ukraine	Ages 18-29: 60%

Note: The value for Ukraine is an average from the two sources given.

Outflows Reduced

The following rates shown in Table S2 were implemented for the Outflows Reduced scenario, with emigration being reduced by 75%, and then correspondingly immigration reduced to fit with the UN's projected global trends (UN 2019) in net migration for upper-middle income countries (Armenia, Georgia, North Macedonia, and Romania) and lower-middle income countries (Ukraine).

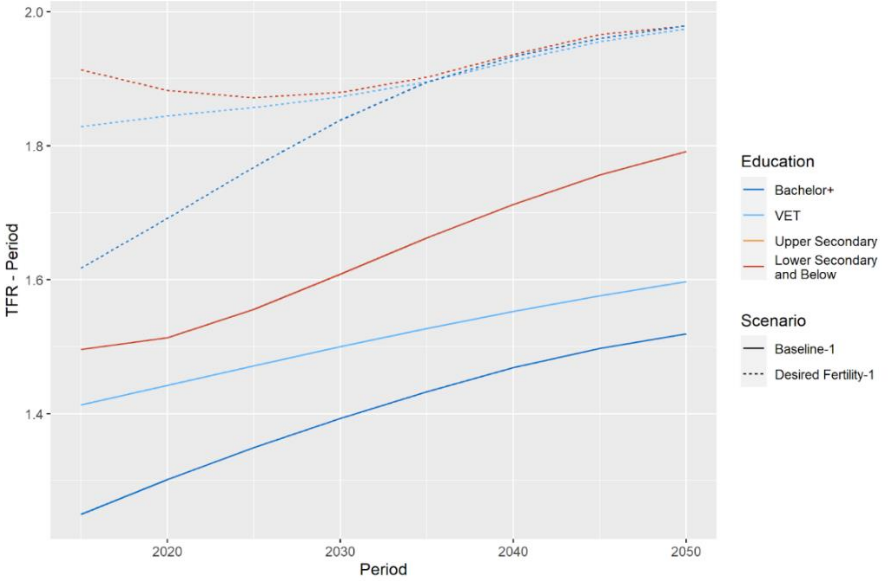
Table S2. Projected UN net migration rates for upper middle-income countries.

	2015-2020	2020-2025	2025-2030	2030-2035	2035-2040	2040-2045	2045-2050
Net migrants per 1000, Upper-middle income countries	-0.113	-0.327	-0.243	-0.169	-0.149	-0.146	-0.144
Net migrants per 1000, Lower-middle income countries	-0.687	-0.549	-0.479	-0.431	-0.409	-0.391	-0.376

Desired Fertility

Fertility rates for the Desired Fertility scenario were implemented using the following sources: Armenia (NSS-AR 2017), Georgia (Ketting & Lomia 2019), North Macedonia (Petreski 2021), Romania (Testa 2012), and Ukraine (UCSR 2008). Figure S4 shows how the TFR for Desired Fertility was gradually implemented compared to the baseline fertility, in this case for the projections of Ukraine.

Fig. S4. TFR by education in Ukraine, Baseline scenario vs. Desired Fertility scenario.



Productivity-Weighted Adjustment:

The relative returns in the countries studied, shown in Table S3, were calculated according to the following country-specific sources: Armenia (Hakobyan & Joulfaian 2016), Georgia (Keshelava 2017), North Macedonia (Mojsoska-Blazevski 2016), Romania (Varly et al. 2014), and Ukraine (Del Carpio et al. 2017).

Table S3. Productivity Weights Implemented by Educational Attainment.

	Primary	Secondary	VET	Tertiary
Armenia	0.833 (m) / 0.797 (f)	1 (m) / 1 (f)	0.992 (m) / 0.862 (f)	1.364 (m) / 1.029 (f)
Georgia	1	1	1.05	1.449
N. Macedonia	0.629	1	1	1.368
Romania	0.851	1	1	1.358
Ukraine	1	1	1.028	1.340

Note: Armenia, Georgia, and Ukraine have marginal populations with primary education or lower.

References:

Abel, G. (2018). Estimates of Global Bilateral Migration Flows by Gender between 1960 and 2015. *International Migration Review*, 52(3), 809–852

Barişik, S.; Budak, S. (2020). Relationship between Education and Productivity within the context of Human Capital: An Analysis on OECD Countries. *The Empirical Economics Letters*, 18(8)

Boc, E. (2020). Opinion of the European Committee of the Regions — Brain Drain in the EU: addressing the challenge at all levels (2020/C 141/08), Official Journal of the European Union [Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52019IR4645&rid=10]

Brunello, G.; Rocco, L. (2015). The effects of vocational education on adult skills and wages: What can we learn from PIAAC?, OECD Social, Employment and Migration Working Papers, No. 168, OECD Publishing [available at: https://doi.org/10.1787/5jrxfmjvw9bt-en].

Cedefop. (2013). Labour market outcomes of vocational education in Europe: Evidence from the European Union labour force survey. Cedefop. Research Paper No. 32, Publications Office of the European Union.

Cedefop. (2016). Romania: Mismatch priority occupations. Skills Panorama – Skills Intelligence powered by Cedefop. [Accessed June 16, 2022:https://skillspanorama.cedefop.europa.eu/en/analytical_highlights/romania-mismatch-priority-occupations#_summary]

Cedefop. (2018). Insights into skill shortages and skill mismatch: learning from Cedefop's European skills and jobs survey. Reference No. 106, Publications Office of the European Union. [Available at: https://data.europa.eu/doi/10.2801/645011]

Cedefop. (2019). Apprenticeship at the workplace: Ucenicia la locul de munca. European database on apprenticeship schemes. [Available at: https://www.cedefop.europa.eu/da/publications-and-resources/data-visualisations/apprenticeship-schemes/scheme-fiches/apprenticeship-workplace]

Cedefop. (2022). European Skills Index: Skills Matching. Cedefop. [Data portal accessed June 16, 2022]

Chukhnova, M. (2020). Ukraine's census attempt crashes and burns yet again. Eurasianet.

Del Carpio, X.; Kupets, O.; Muller, N.; Olefir, A. (2017). Skills for a Modern Ukraine. Directions in Development--Human Development. Washington DC, World Bank, (2017). [available at: https://openknowledge.worldbank.org/handle/10986/25741]

Deutsche Welle. (2018). With a rapidly aging population, Germany looks to Balkans for care workers. [Available at: https://p.dw.com/p/39IZm]

Deutsche Welle (2020). Germany: Merkel's CDU eyes Western Balkans immigration curbs amid coronavirus. [Available at: https://p.dw.com/p/3eRzr]

Drobchak, A.L.; Korop, A.O.; Asaulenko, V.V. (2019). Youth Migration from Ukraine: Causes, Factors and Possible Consequences, *Market Infrastructure*, 30(477).

Economist, The. (2021). How the pandemic reversed old migration patterns in Europe. Jan 30th, 2021 edition.

European Commission (EC). (2018). Country Report Romania 2018. Commission Staff Working Document: 52018SC0221. European Commission, Brussels.

European Commission (EC). (2019). Education and Training Monitor 2019: Country analysis. Directorate-General for Education, Youth, Sport and Culture, Luxembourg: Publications Office of the European Union.

European Training Foundation (ETF). (2013). Migration and Skills in Armenia and Georgia: Comparative Report. Turin, Italy.

European Training Foundation (ETF) (2020). North Macedonia: Education, Training, and Employment Developments 2020. European Training Foundation. Available at: https://www.etf.europa.eu/sites/default/files/document/Country%20Fiche%202020%20North%20Macedonia%20Education%20Training%20and%20Employment%20Developments.pdf

Fleming, S., Peel, M., & Hopkins, V. (2019). Falling populations pose 'existential' risk, Croatia warns EU. Financial Times.

Galevski, M. (2019). Participation of Youth in North Macedonia: Apathy, Optimism or Disappointment? Study 2019. Westminster Foundation for Democracy, North Macedonia.

Hakobyan, S.; Joulfaian, D. (2016). The Return to Education in Armenia. *Armenian Journal of Economics* (2).

International Organization for Migration (IOM) [Moldova] and UN Women (UNW) [Moldova]. (2022). Updated Displacement Survey: Ukrainian Refugees and Third-Country Nationals: Displacement patterns, needs and intentions survey, 9–27 March 2022.

International Labour Organization (ILO). (2022). Labor force participation rate, total (% of total population ages 15+) (modeled ILO estimate). ILOSTAT database: Data retrieved on February 8, 2022 (2022). [Accessed June 16, 2022 via The World Bank's open data portal].

KC, S.; Lutz, W.; Potančoková, M.; Guy, A.; Barakat, B.; Eder, J.; Goujon, A.; Jurasszovich, S.; Sobotka, T.; Speringer, M.; Striessnig, E.; Wurzer, M.; Yildiz, D.; Hyun Yoo, S.; Zeman, K. (2018). Chapter 2: Approach, methods and assumptions," in Lutz W., A. Goujon, S. KC, M. Stonawski, N. Stilianakis [eds.], Demographic and human capital scenarios for the 21st century. Luxembourg: Publications Office of the European Union: 19-28.

Keshelava, D. (2017) In Georgia Education Matters (But Probably Will Not Make You Rich), International School of Economics at Tbilisi State University: Economist Blog.

Ketting, E.; Lomia, N. (2019). Sexual and Reproductive Health in Georgia: Selected Data Analysis & Dynamics". United Nations Population Fund (UNFPA). Georgia Country Office. ISBN 978-9941-8-22193.

Leitner, S. (2021). Net Migration and its Skill Composition in the Western Balkan Countries between 2010 and 2019: Results from a Cohort Approach Analysis. Vienna Institute for International Economic Studies, Working Paper 197

Libanova, E.; Cymbal, A.; Lisogor, L.; Iarosh, O. (2016). Labour market transitions of young women and men in Ukraine: Results of the 2013 and 2015 school-to-work transition surveys. Work4Youth Publication Series No. 41, International Labour Office.

Luecke, M.; Saha, D. (2019). Labour migration from Ukraine since 2014. Policy Briefing Series, PB/08/2019, German Advisory Group, Ukraine.

Lutz, W.; KC., S. (2011). Global Human Capital: Integrating Education and Population, Science, Vol 333, Issue 6042, pp. 587-592

Lutz, W.; Goujon, A.; KC, S.; Stonawski, M.; Stilianakis, N. (2018). Demographic and Human Capital Scenarios for the 21st Century: 2018 assessment for 201 countries. EUR 29113 EN, Publications Office of the European Union, Luxembourg. ISBN 978-92-79-78024-0 (online).

Lutz, W.; Amran, G.; Belanger, A.; Conte, A.; Gailey, N.; Ghio, D.; Grapsa, E.; Jensen, K.; et al. (2019). Demographic Scenarios for the EU: Migration, population and education. Publications Office of the European Union , Luxembourg. 10.2760/590301.

Mojsoska-Blazevski, N. (2016). The State Statistical Office of Macedonia. Labour market transitions of young women and men in the former Yugoslav Republic of Macedonia: Results of the 2014 school-to-work transition survey. International Labour Office.

Mostovaya, Y.; Rohmanin, S. (2017). Кровотечение: Почему украинцы покидают свою страну. ZN.UA and Kiev International Institute of Sociology, (2017). [Accessed Aug 17, 2021. Available at: https://zn.ua/project/emigration/]

National Statistical Service [Armenia], Ministry of Health [Armenia], and ICF. (2017). Armenia Demographic and Health Survey 2015-16. Rockville, Maryland, USA: National Statistical Service, Ministry of Health, and ICF.

National Statistics Office of Georgia (Geostat). (2021). Labour Force Survey Database 2020 Year. Reference ID: GEO_2020_LFS_v01_M_ILO_VAR

National Statistics Office of Georgia (Geostat). (2022). Mid-year population by age and sex.

Organisation for Economic Co-operation and Development (OECD). (2019). Talent Abroad: A Review of Romanian Emigrants. OECD Publishing, Paris. [Available at: https://doi.org/10.1787/bac53150-en]

Organisation for Economic Co-operation and Development (OECD) and World Bank (WB). (2022). Database on Immigrants in OECD Countries – Extended 2010/11. [Accessed March 1, 2022: https://www.oecd.org/els/mig/dioc.htm].

Petreski, M. (2021). How Migration, Human Capital and the Labour Market Interact in North Macedonia. European Training Foundation.

Razumkov Center (2022). Attitudes and Assessments of Ukrainian Refugees Who Return Home (April–May, 2022).

Rogers, A.; Castro, L.J. (1981). Model Migration Schedules. IIASA Research Report. IIASA, Laxenburg, Austria: RR-81-030.

Roman, M.; Vasilescu, D. (2016). Explaining the Migration Intentions Of Romanian Youth: Are Teenegers Different?. *Romanian Statistical Review*, 64(4), 69-86. (2016).

Ruben, A.; Christiansen, L.; Dizioli, A.; Ebeke, C.; Ilahi, N.; Ilyina, A.; Mehrez, G.; Qu, H.; Raei, F.; Rhee, A.; Zakharovaet, D. (2016). Emigration and Its Economic Impact on Eastern Europe. (Staff Discussion Notes 16 (7):1, International Monetary Fund).

Saavedra, T.; Cancho, C.A.; Fuchs, A. (2019). Armenia International Outmigration: An Exploration on the Effects on Armenian Households' Welfare. World Bank, Washington, DC.

Sanderson, W.C.; Scherbov, S. (2008). Rethinking age and aging. *Population Bulletin* 63 (4), 1-16.

Sanderson, W.C.; Scherbov, S. (2010). Remeasuring aging. *Science* 329 (5997), 1287-1288.10.1126/science.1193647.

Sandu, D.; Stoica, K.A.; Umbres, R. (2014). Romanian Youth: Concerns, Aspirations, Values, and Life-Styles. Center for Urban and Regional Sociology – CURS for Friedrich-Ebert-Stiftung Romania (FES).

Sobotka, T.; Matysiak, A.; Brzozowska, Z. (2019). Policy responses to low fertility: How effective are they?. UNFPA, Working Paper No. 1

State Commission on Migration Issues. (2017). 2017 Migration Profile of Georgia, Secretariat of the State Commission on Migration Issues.

State Statistics Service of Ukraine. (2021). Resident Population of Ukraine by Sex and Age, as of January 1, 2021. Statistical publication.

State Statistics Service of Ukraine (2022). Resident Population of Ukraine by Sex and Age, on January 1, 2020.

State Statistical Office [North Macedonia]. (2022). Census of Population, Households and Dwellings in the Republic of North Macedonia, 2021 - first dataset.

Testa, M.R. (2012). Family sizes in Europe. Evidence from the 2011 Eurobarometer survey". Vienna Institute of Demography, Austrian Academy of Sciences, European Demographic Research Papers 2012, No. 2.

Ukrainian Center for Social Reforms (UCSR), State Statistical Committee (SSC) [Ukraine], Ministry of Health (MOH) [Ukraine], and Macro International Inc. (2008). Ukraine Demographic and Health Survey 2007. Calverton, Maryland, USA: UCSR and Macro International.

United Nations (UN). (2017). World Population Prospects: The 2017 Revision, Volume I: Comprehensive Tables. Department of Economic and Social Affairs, Population Division, United Nations

United Nations (UN). (2019). World Population Prospects 2019: Volume I: Comprehensive Tables. Department of Economic and Social Affairs, Population Division.

United Nations (UN). (2022). International Migrant Stock 2020. United Nations: Population Division. [Accessed June 25, 2022: https://www.un.org/development/desa/pd/content/international-migrant-stock].

United Nations High Commissioner for Refugees (UNHCR)(a). (2022). Refugees fleeing Ukraine (since 24 February 2022). Operational Data Portal. [Data portal accessed: April 24, 2022]. Available at: https://data.unhcr.org/en/situations/ukraine

United Nations High Commissioner for Refugees (UNHCR)(b). (2022). Operational Data Portal: Ukraine Refugee Situation – Poland, data as of June 22 (2022). [Available at: https://data2.unhcr.org/en/situations/ukraine/location/10781]

Varly, P.; Şerban Iosifescu, C.; Fartuşnic, C.; Costache, L. (2014). Cost of Non-investment in Education in Romania: Final Report for UNICEF.

Vercauteren, S. (2019). Return Migration to Eastern Europe: Characteristics of the Returnees and Return-Stimulating Policies. Faculty of Economics and Business Administration, *Univ. of Gent*.

World Economic Forum (WEF) (2017). The Executive Opinion Survey: The Voice of the Business Community. The Global Competitiveness Report 2017–2018. Geneva: [Available at: https://reports.weforum.org/global-competitiveness-index-2017-2018/competitiveness-rankings/#series=EOSQ399]

World Health Organization (WHO). (2022). Life expectancy and Healthy life expectancy, The Global Health Observatory. [Data portal accessed June 16, 2022: https://www.who.int/data/gho/data/themes/topics/indicator-groups/indicator-group-details/GHO/life-expectancy-and-healthy-life-expectancy]