Guillaume Marois, Michaela Potančoková and Miguel González-Leonardo

Technical report: QuantMig-Mic microsimulation population projection model

Deliverable 8.2

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List of Acronyms

DIOC-2011 – Database on Immigrants in OECD and non-OECD Countries, reference year 2010/2011 https://www.oecd.org/els/mig/dioc.htm

EU+ – An aggregate of 31 European countries, includes 27 EU countries, the United Kingdom, and three EFTA countries (Iceland, Norway and Switzerland)

EU-LFS – European Union Labour Force Survey - https://ec.europa.eu/eurostat/web/microdata/european-union-labour-force-survey

Eurostat – Statistical office of the European Union - https://ec.europa.eu/eurostat

ESS – European Social Survey

Research projects

CEPAM – Centre of Expertise on Population and Migration https://migration-demography-tools.jrc.ec.europa.eu/catalogue/dataset/pj00207

QuantMig – Quantifying Migration Scenarios for Better Policy https://quantmig.eu

1. Introduction

This document complements and extends the technical report in Deliverable 8.1 QuantMig microsimulation tool description (Marois and Potančoková 2022) which was underpinning the QuantMig-Mic model code and explaining its structure and the MODGEN user interface. This technical cover document is a full documentation of the Quant-Mig-Mic microsimulation population projection model for 31 European countries (EU27 member states, the United Kingdom, Iceland, Norway and Switzerland, referred to as EU+ in this report), its modules, parameters, assumptions and migration scenarios.

In addition to Deliverable 8.1, which documents work in progress on the model code, we now include detailed description of data sources and statistical models employed to derive the model parameters. Compared to the model version described in Deliverable 8.1, the architecture of the model remained identical but a few changes were made in the model code to implement differentials by place of birth in emigration and support migration scenarios implementation. We have, for example, added an option to flexibly introduce convergence in emigration rates separately by region of birth and with different starting periods and for various durations until the convergence.

Parameters in several models were updated: the mobility and outmigration module parameters were updated with parameters derived from the Deliverable 6.3 (Aristotelous et al. 2022), the mobility module has been extended by differential emigration rates for native-born, EU+born and born outside EU+. Mortality rates and fertility rates by age and educational attainment now reflect the COVID-19 pandemic impacts and correspond to those from the updated SSP2[1] scenario (KC et al. 2023).

This report also introduces the assumptions and QuantMig migration scenarios of high migration events into the EU+. These quantitative model-based scenarios are embedded in statistical theory of extreme values and implement the estimates of extreme migration events of once-in-a-decade and twice-in-a-century frequency of occurrence (Bijak 2023) from different world regions into the modelling as one-off migration events or as events with persistent migration from the region following the initial high migration event. The scenarios are described in section 3. In this report we focus on the scenario operationalisation and implementation in the modelling. The results, including the sensitivity analysis, will be presented and discussed in the discussion paper (Potančoková et al. 2023a).

The model code and all scenarios are publicly available in Zenodo repository under "QuantMig microsimulation population projection model and migration scenarios for 31 European countries" (Potančoková et al. 2023b) as of August 2023.

2. General description of the QuantMig-Mic microsimulation model

[1] Shared Socio Economic Pathways (SSP) scenario SSP2 is the middle-of-the-road scenario which envisages continuation of the recent decades, envisaging some progress towards achieving development goals and reductions in fossil fuels dependency. For more details see KC and Lutz (2017).

Microsimulation is an alternative approach to the deterministic macro-level population projection models that use aggregate level data to project future population size and composition using cohort-component method. Microsimulation is a powerful tool that can account for larger number of individual characteristics as well as interactions between the actors and is well suited for forecasting population projection diversity in terms of socio-economic and cultural population characteristics (Van Imhoff and Post 1998). Microsimulation modelling utilises individual level data, allows for links between the actors to capture complex and multidimensional life course transitions, such as for example intergenerational transmission of characteristics from a parent to a child. The transitions between the states are determined stochastically.

QuantMig-Mic microsimulation projection model has been developed to forecast the population of EU+ countries with a specific focus on the place of birth as source of heterogeneity in demographic and economic behaviors. The model is dynamic and time-based, with continuous time. It simulates the life course of individuals with Monte Carlo random process for events the actors experience. The model is based on, but also extends, the CEPAM-Mic model (Bélanger et al. 2019; Marois, Sabourin, and Bélanger 2019b; 2019a; Potančoková and Marois 2020), which was developed between 2016–2019 by a partnership between the International Institute for Applied Systems Analysis and the Joint Research Center of the European Commission. Both models were built following the framework proposed by Bélanger et al. (2019) to study population changes in a context of relatively high immigration and low fertility.

Though both models share the same framework and coding language (Modgen) (Bélanger and Sabourin 2017), the modeling of many modules as well as nearly all assumptions differ in many ways. While CEPAM-Mic was built for 28 countries of what was back the European Union (including the UK), QuantMig-Mic is extended to also include three EFTA countries: Norway, Iceland, and Switzerland. In addition, the starting population is updated to take into account more recent demographic trends and to explicitly include consistently the place of birth as a core variable. This document presents summarily the different modules of QuantMig-Mic and details how they differ from CEPAM-Mic.

QuantMig-Mic explicitly includes the region of birth as a core dimension of the model (CEPAM-Mic distinguished only between the native-born, EU28-born and born outside the EU28). The categories for the region of birth variable are based on the European Labour Force Survey's (EU-LFS) definition because EU-LFS data were used in parameter estimation and modeling in several modules. Region of birth categories for persons born outside EU+ are as follows[2]:

1. Other Europe (Turkey, as well as Eastern European and Western Balkan countries which are not included in the EU+ aggregate, such as e.g. Ukraine, Russia, Belarus, Serbia)
2. Latin America
3. North Africa

[2] The world regions are determined by the classification used the EU-LFS 2012-2019 COUNTRYB variable: Europe Outside EU-28 and EFTA (includes Turkey, Russian Federation and other Eastern European countries); North Africa; Other Africa; Near Middle East; East Asia; South South-East Asia; North America & Australia Oceania; Latin America. Since EU-LFS 2020, the region of birth categories changed in order to reflect Brexit. For the country grouping for each region see the EU-LFS documentation: https://ec.europa.eu/eurostat/documents/1978984/6037342/Country-codification-from-2012-onwards.pdf

4. Sub-Saharan Africa
5. East Asia
6. West Asia
7. South & South-East Asia
8. Northern America + Oceania[3]

The complete coding of the place of birth variable includes 39 categories: the 31 EU+ countries of residence included in the model, plus the above-listed eight broad world regions of birth for international immigrants from the rest of the world. For some modules, however, some categories are grouped into simplified place of birth variable, either because the sample size for some of them were not big enough or because the source used to estimate parameters does not distinguish them.

QuantMig-Mic model dimensions of the model are as follows:

- age[4]
- sex [male, female]
- country of residence [31 European (EU+) countries]
- place of birth [31 European (EU+) countries and eight broad world regions]
- labour force participation [active, inactive]
- employment [employed, unemployed]
- age at immigration[5]
- duration of residence [0-4, …, 20+ years]
- educational attainment (3 categories based on ISCED 2011 classification)[6]
- educational attainment of the mother (3 categories based on ISCED 2011 classification)
- religion [Christian, Unaffiliated, Muslim, Other]
- language spoken at home [Official Language in Country of Residence, Other EU official language, Other languages]

Individuals from the base population (synthetic baseline based on census 2011 data, EU-LFS and imputed socio-cultural variable from the European Social Survey, ESS waves 1-7) are simulated one by one, and their characteristics are modified through scheduled events whose timing is determined by Monte-Carlo process, meaning that a random number is generated and compared to the probability of experiencing given transition. If this number is larger than the given probability,

[3] Because of generally small number of persons born in North America and in Australia and Oceania we combined these two EU-LFS regions into a single region in the model.
[4] The model runs in continuous time; 5-year age groups are used in the output [0-4, …, 95+].
[5] The variable 'generation status' is derived from the age at immigration. The categories of this variable are the real age. Then we create 3-categories more general categories of the variable for the generation status: G1 – immigrants who arrived as adults, G1.5 – immigrants who arrived as children (by age 15), and G2 – descendants of immigrant parents.
[6] Low: none or ISCED1-2, i.e. lower secondary or below; Medium: ISCED 3, i.e. completed upper secondary; High: ISCED 4 or higher, i.e. post-secondary non-university or tertiary (university) education.

then transition happens and the person's state changes. The model is case-based, meaning that each individual is simulated separately from other individuals and that no interactions between individuals are allowed (with the exception of interactions between mother and children). The model is also dynamic and in continuous time, meaning that characteristics of individuals are modified continuously in "real time", in contrast to discrete-time models where characteristics are changed within predefined time units (typically one year such as in population projections of the Eurostat or five years such as in population projection of UN's World Population Prospects).

Simultaneous simulation of individual life courses means that the model dynamically updates the risks of various events based on an individual's state. QuantMig-Mic allows for changes in individual characteristics over the life course as well as for intergenerational transfers of some characteristics from mother to child. This interaction is used to model educational attainment of individuals following evidence on intergenerational transmission of education which differs across social groups (Marois et al. 2019a). Educational attainment, in turn, is instrumental in modelling of demographic events and labour market participation of population groups (Marois et al. 2019b).

The modelling starts with a baseline population which represents population of all 31 EU+ countries at the time of the respective 2011 censuses. The horizon of the simulation is set to 2060 but the tool allows the users to set later projection horizons, given that projection assumptions for later years are available and provided into the model. QuantMig-Mic microsimulation tool allows the study of alternative scenarios of migration into the EU+ and their consequences for future population and trends and the labour supply. Socio-cultural variable such as religion and language are not utilised in the outputs, but are used inside the model for the modelling of educational attainment (for more details see Marois et al. 2019a).

2.1 Base population and pre-simulation

2.1.1 Base population

Any microsimulation model requires high-quality, reliable, and accurate individual-level data for the base population in all its simulated characteristics. Generating the synthetic baseline population requires a) counts of the real population by a set of characteristics of interest and b) case generation rules which set how big subpopulation an actor represents. We describe both and the data sources used in this section. For the QuantMig-Mic we build a synthetic baseline population that represents populations in 31 simulated countries by 13 characteristics[7]. Since there is no single data source that would contain all these variables for all countries, we combine the census 2011, EU-LFS and European Social Survey (ESS) data to derive the baseline population. We start with census 2011 population stocks which to date provide the most reliable information on population counts by age, sex, region of birth and educational attainment[8]. The EU-LFS is used to derive the labour force characteristics, duration of stay in the country of residence and the age of arrival to the country of

[7] CEPAM model, the predecessor of QuantMig-Mic, used EU-LFS microdata for the baseline population, however, these were insufficient for the extension of the foreign-born population by region of birth. Further, EU-LFS data for Iceland, Norway and Switzerland do not include population below age 15.

[8] The base population of the QuantMig-Mic model is different from the one in CEPAM model which used EU-LFS microdata. This change was made due to deficiencies in the EU-Labour Force Survey data especially with respect to foreign-born populations, and reduced information in the EU-LFS for the EFTA countries which were added and for which LFS files do not provide person records younger than adult population.

residence. Socio-cultural variables (religion, language spoken at home) are not included in the EU-LFS (and neither in Eurostat's CensusHub census 2011 data) and were imputed using ESS 2014-2019.

We collected the census data from Eurostat's CensusHub (ec.europa.eu/CensusHub2), IPUMS[9] for Spain, and custom tabulations from the national statistical offices for the Netherlands and Luxembourg. Population by country of residence, five-year age groups, sex and place of birth was available for all 31 countries. Population distributions by age, sex, place of birth and educational attainment were available for 23 countries and not available for Denmark, Germany, Italy, Lithuania, Luxembourg, the Netherlands, Norway, and Sweden. For all 31 countries we could obtain age, sex and educational attainment for the native-born and persons born in another EU+ country but the tabulations for foreign-born outside the EU+ were not available in exactly the same categorizations as in the EU-LFS for all world regions. The reason was that four-way tabulation only allowed to select continents and larger regions of origin not individual countries so we could not group individual countries of birth into our region definitions for the four-way table. Thus, we needed to combine Eurostat data with DIOC-2011 dataset, and we describe this in more detail below (see also Appendix A for specific data sources per country of residence and place of birth). IPUMS for Spain allowed us to classify place of birth accurately into the native-born, born in another EU+ country, and the eight world regions and we used weighted counts calibrated to census 2011 counts from the CensusHub by five-year age and sex.

To sum up, we have utilised in formation the CensusHub tabulation and IPUMS to the level possible and then collected additional data from other data sources to estimate populations by age, sex, and educational attainment for those regions of birth where CensusHub data were insufficient. We could directly use population by age, sex and educational attainment for the native-born, born in another EU+ country, born in Latin America and born in North America and Oceania, i.e. for those regions that correspond to continents. We could, however, extract population counts for individual countries of birth population counts by age, sex and country of birth (i.e. three-way table omitting educational attainment). This was already an important piece of information as we then collected additional data on educational attainment from the OECD's DIOC-2011[10] database and we could use there to obtain educational distributions for persons born in Other Europe, North Africa, Sub-Saharan Africa, East Asia, West Asia and South & South-East Asia. To make the matter more complicated we needed to extract data for Turkey which was included in Asia region in CensusHub but in Other Europe region in EU-LFS definition we use. DIOC-2011 educational distributions for native-born, and groups of foreign-born were also used for Denmark, Germany, Italy, Luxembourg, the Netherlands, Norway and Sweden. For Lithuania we could not obtain educational attainment data for the foreign-born population. Thus, we imputed the census counts by age, sex and place of birth using the educational distributions for each respective groups as in Latvia.

In addition, the DIOC-2011 dataset was used to obtain education attainment distributions for North Africa, Sub-Saharan Africa, East Asia, West Asia and South & South-East Asia by grouping available countries of origin. Validation for population counts by place of birth revealed that in most countries the match between Eurostat and DIOC-2011 match well where census 2011 was the main data source for DIOC[11]. The exception was Germany for which only data for a limited number of

[9] IPUMS international: https://international.ipums.org/international/ Sample used: census 2011 for Spain, variables: age, sex, educes, bplcountry.

[10] Available at: https://www.oecd.org/els/mig/dioc.htm

[11] DIOC-2011 used in some instances national Labour Force Survey data and not census 2011. In such cases the

countries of origin was available in DIOC, however, in absence with any more complete information we used these educational distributions are proxies. DIOC published data in broader, ten-year age groups, and we applied proportional fitting to match counts by five-year age groups, sex and continent of birth as reported by the CensusHub.

Missing values (unknown) in age and sex variables were very minor and were ignored (the cases were dropped). Therefore, our baseline population corresponds to the census counts of persons with known age and sex. Missing values (unknown) for the place of birth were randomly distributed. Missing values for educational attainment variable differed by place of birth and also by age with some age groups having higher missingness. For the native-born the information on educational attainment was nearly complete. In some countries and for some specific subgroups, however, we identified sizeable missingness for educational attainment the foreign-born. African-born in Belgium with 45% of missing in educational attainment in some age groups were an extreme case, but we found high levels of missingness in some age groups also for Africans in Denmark (up to 25%) and Latin Americans in Czechia (up to 50%, due to small cell sizes). In all instances we redistributed missing education counts proportionally assuming they would have the same education distribution as the reported cases within each age, sex and place of birth category. Greater uncertainty about educational attainment of foreign-born is not surprising, and in the absence of other data we assume that the relevant information was missing at random. If the missingness is selective and persons with no education or low educational attainment are more likely not to report their education, then the estimated educational compositions may overestimate educational attainment for those subgroups – either in terms of place of birth, sex or age or their combinations – may be higher than the true educational distribution. Census data, regardless of their deficiencies, to date present the most complete and most reliable source of information on migrant education.

Labour force status has been added to the estimated populations by country of residence, age, sex, place of birth and educational attainment using the EU-LFS 2014-2019 and utilizing information from the ilostat variable (simplifying into binary active and inactive). We apply International Labour Organisation (ILO) international definition of active population according to which employed persons and job seekers are considered as active in the labour force[12]. The religion and the language spoken at home are then imputed from the ESS. All waves of the ESS available at the time of analysis (1 to 9) were used to include as many countries as possible and to maximize sample size. For Malta, which is not participating in the ESS, we used Eurobarometer 77.4, which included a question on religious denomination; language of interview was used as a proxy for language spoken at home. The goal is to get, for every combination of the variables available in the base population, a statistical distribution by religion and language spoken at home.

Multiple imputation algorithms such as MICE (R package) could not accommodate the number of variables we wanted to include in the analysis due to limitations in computer processing power and resources. Also, many variable combinations yielded empty cells, which made the

discrepancies were considerable, such as for Switzerland. We refrained from using Switzerland DIOC-2011 data. Similar situation was for Austria – again LFS data were used by DIOC and from the NSO statcube (https://www.statistik.at/datenbanken/statcube-statistische-datenbank) online database we could only extract data for the main individual countries of birth and we could not collect information for all counties of birth in Africa or Asia (again, only continents were provided at the aggregate level, not subregions).

[12] For more definitions see https://www.insee.fr/en/metadonnees/definition/c1946 and European Union (20190

estimations even more difficult. Using only a subset of the base population variables with MICE resulted in incoherences between imputations and empirical data.

Due to limitations in sample size and to ensure a maximum of flexibility, we used an iterative method where distributions according to religion and language were estimated using an increasing number of variables, while keeping the sample size above a threshold value.

To be more specific, we started by imputing religion. As a first approximation, the national average distribution was used for all base population variable combinations in each country (i.e. the probability of being from a certain religious denomination was the same for everyone in a given country). In a second step, we looked at religion distributions for cross-combinations of country of residence and place of birth. When sample size for a given combination was above a certain threshold (we used N=10), the national average was replaced by a new estimation by country of residence and country of birth. In a third step, we added education and again looked for country of residence, country of birth and education combinations with sufficient sample size to improve our estimation. This sequence was repeated again for age, years since migration and sex, in that order. For Malta, only country of birth was considered.

Language was imputed after religion. The imputation procedure was the same as for religion, but we used a different set of variables. We started with country of residence, and then added place of birth, religion, age and education.

The resulting distributions for religion and language were then integrated as parameters in the model and used during the simulation to generate characteristics of new actors.

We are aware that this procedure is not ideal as the order in which variables are introduced will affect distribution values. Nevertheless, the method ensured a coherence in the results and provided estimates for all combinations of variables in the base population. Moreover, it gave us control over the estimation process, something automated algorithms, even though statistically more accurate, cannot provide.

The base population takes the form of a database in which each line contains a record of an individual (simulated actor) and each column gives a value of a variable in a given record. Each actor (a line in the database) represents a certain population witch a given set of characteristics. Generating a fully synthetic baseline population requires (a) counts of the real population by a set of characteristics of interest, and (b) case generation rules which set how big subpopulation an actor represents.

The synthetic base population has been prepared with sampling rules that assure oversampling of actors from less-represented population groups, which is particularly important given the focus of the QuantMig project on migration and the aim is to allow for analyses for specific subgroups of foreign born populations, for example by combining demographic characteristics and region of birth.

The case generation rules are implemented in the model as a parameter. This parameter allows to flexibly set how many actors are generated in the synthetic baseline population for each subpopulation, based on its size in the real population. This is because for some combinations of place of residence, place of origin, age, sex and educational attainment, only a very small stock of individuals exists in the respective populations represented by the census 2011 data. These case generation rules are specified as follows:

- Two actors for a subgroup of up to 30 individuals
- 10 actors for a subgroup counting between 30 and 100 individuals

- 30 actors for a subgroup counting between 100 and 1000 individuals
- 40 actors for a subgroup counting between 1000 and 10 000 individuals
- 0.05% of the subgroup size for subgroups counting more than 10 000 individuals

The baseline population file is publicly available in the QuantMig Zenodo repository (Potančoková et al. 2023b).

2.1.2 Pre-simulation for 2011–2019

From the initial synthetic 2011 baseline population described above, QuantMig-Mic proceeds to a pre-simulation replicating the demographic dynamic in EU+ countries for the period 2011–2019. When necessary and when data are available, the events of all component modules are calibrated to match with the official estimated numbers at the country level. Pre-simulation is calibrated to demographic events (births and deaths) as reported by Eurostat for 2011–2019, labour force participation from the EU-LFS and median migration flows for 2011–2019 (Aristotelous et al. 2022). Simulation of future population projection scenarios starts from 2020 and is set to 2060.

Births for 2011-2019

The number of births for the pre-simulation is generated by the fertility module (see section 2.2.1 for details) and takes into account differentials in fertility behaviours according to educational attainment, place of birth and the duration of stay for immigrants. The total number of births is calibrated to match the estimates of Eurostat from 2011–2014 and 2015–2019[13] separately.

Deaths for 2011-2019

The mortality module, described in further detail in section 2.2.2, is used to generate the number of deaths from 2011 to 2019. Given that no major unusual events impacted trends in mortality rates from 2011 to 2019, the simulated number of deaths per country match those estimated by Eurostat without any further calibrations.

Migrants for 2011-2019

In the mobility module[14], two different dimensions are pre-simulated: migration amongst EU+ countries, and emigration from each EU+ country to the rest of world. Immigrants into the EU+ from the rest of the world are brought into model from an immigration database. Immigration database stores the immigrant counts by their characteristics, for more details see section 2.2.5.2. Parameters and the workings of the mobility module are described in more detail in section 2.2.3. Data for the pre-simulation were taken from estimated median origin-destination flows produced by Aristotelous et al. (2022) for the period 2011–2019[15], who adjusted with Bayesian methods migration flows reported from Eurostat in order to account for the inaccuracy and inconsistent definitions of official estimates, and levels of under- and over-reporting across countries.

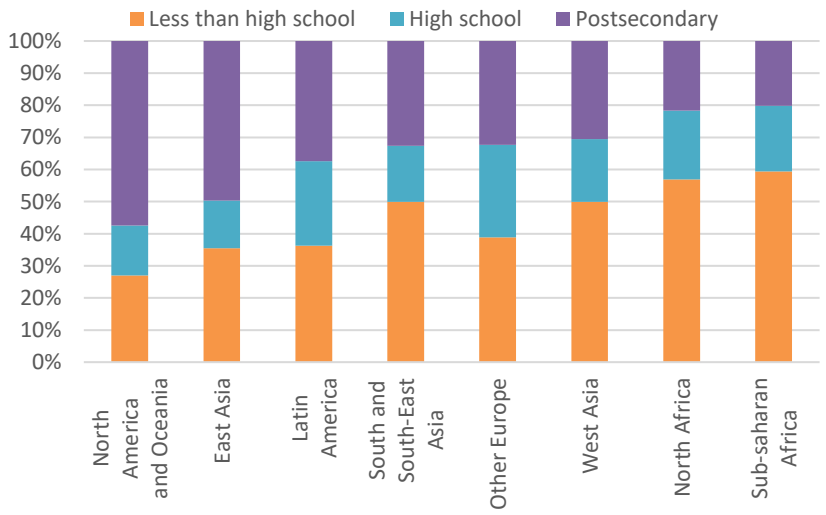
[13] We calibrated to data from the EUROSTAT table on live births (demo_fasec), last visited 31.05.2022.
[14] Mobility module is the expression used in the model code and the MODGEN user interface.
[15] We used Eurostat data for international migration from the other world regions in Germany instead of estimates for Aristotelous et al., (2022), since estimated flows were exceptionally low compared to observed figures.

The only exception are flows between Germany and the rest of the world regions for 2015–2019 which were manually adjusted to match total flows as reported by the Eurostat. The reason for this is that due to lack of data on bilateral flows between Germany and other countries reported to the Eurostat database, the modelled true migration flows were too low especially for years 2015 and 2016 when compared to Eurostat data on migration by country of birth. While we acknowledge that country of origin and country of birth are not the same, for immigrants we expect good overlap.

However, the comparisons between the modelled true immigration flows and data on immigrants born outside the EU (Eurostat table migr_imm3ctb) showed that the reported flows for 2015 and 2016 lay outside the uncertainty bounds of modelled values and the median flows are thus severely underestimated. In other words, due to data deficiencies the modelled data could not capture well the migration wave of 2015–2016. We have thus calibrated the flows between Germany and the rest of the world regions to the data reported by Eurostat for immigrants born outside the EU by calculating a ratio between the median flows from/to rest of the world and immigration flows by country of birth from Eurostat and used it as a factor to inflate the flows for Germany. Flows between Germany and other EU+ countries were not adjusted, and we used median flows from the origin-destination matrix by Aristotelous et al. (2022).

The pre-simulation of QuantMig-Mic reproduces the population dynamic from 2011 to 2019 and provides a synthetic base population as of 1st January2020 with different dimensions of the model. Scenarios start diverging only after 2020. The age distribution of immigrants arrived into destination countries in pre-simulation immigrants arrived during the pre-simulation period of the model (2011–2019) is assumed to follow Rogers-Castro age schedule adjusted for developed nations (Sander, Abel, and Riosmena 2014), and the validation to the age profiles of bilateral median flows from the rest of the world regions showed a good match and no significant deviations. This is not surprising because age patterns of immigrants tend to be very stable with maximum in early adulthood (see also Mooyaart and de Valk 2020 for European migration). Educational composition is inferred from the foreign-born population age 20 and over and arrived in the country at the of age 20 and above in the EU-LFS 2014-2019 (see equation (1) in section 2.2.3). Figures 1 and 2, respectively, show the distributions of immigrants born outside EU+ by educational attainment and by country of destination in 2011–2019.

Figure 1. Educational attainment of the immigrants (age 15+) who arrived in Europe between 2011 and 2019, by region of birth



Source: Authors' calculation from EU-LFS 2010-2019

Figure 2. Heatmap of the country of destination for immigrants from the rest of the world regions arrived in EU+ between 2011 and 2019

(1 = as likely as all migrants to settle in the country)

Country of destination	Region of origin*							
	East Asia	Latin America	North Africa	North America and Oceania	Other Europe**	Sub-saharan Africa	South and South-East Asia	West Asia
AT	0.6	0.2	0.4	0.5	2.1	0.4	1.0	1.8
BE	0.7	0.5	1.7	0.8	0.7	1.9	0.9	1.2
BG	0.2	0.0	0.1	0.5	4.0	0.1	0.1	1.2
CH	1.4	1.0	0.5	2.0	1.1	0.7	0.9	0.6
CY	0.4	0.2	0.7	0.7	1.4	1.5	1.2	1.4
CZ	0.9	0.3	0.4	0.8	2.6	0.7	0.8	0.5
DE	0.8	0.3	0.5	0.4	1.6	0.7	0.9	2.3
DK	1.0	0.3	0.2	1.9	0.8	0.7	1.4	1.6
EE	0.3	0.1	0.1	1.0	3.7	0.2	0.3	0.5
ES	0.5	3.7	1.9	0.4	0.3	0.5	0.4	0.1
FI	0.9	0.2	0.3	0.9	1.3	0.9	1.5	1.5
FR	1.0	0.8	2.5	1.0	0.5	1.8	0.9	0.5
GR	0.6	0.3	1.1	0.9	1.7	1.2	0.8	1.1
HR	0.3	0.1	0.0	0.6	4.6	0.1	0.1	0.1
HU	1.5	0.4	0.8	1.0	1.6	0.7	0.9	1.0
IE	1.0	0.9	0.2	5.3	0.1	0.7	0.7	0.5
IS	0.7	0.5	0.2	3.3	0.8	0.6	1.3	0.7
IT	0.9	1.0	1.9	0.2	1.1	1.5	1.2	0.2
LT	0.2	0.1	0.1	1.0	3.9	0.1	0.3	0.6
LU	0.9	0.8	0.7	1.8	1.4	1.5	0.6	0.3
LV	0.5	0.1	0.1	0.4	3.9	0.2	0.1	0.9
MT	0.6	0.3	1.7	2.4	0.5	2.3	0.6	0.6
NL	1.3	0.8	0.7	1.4	0.7	1.0	1.0	1.4
NO	0.6	0.3	0.3	0.9	0.7	1.8	1.6	1.5
PL	0.6	0.3	0.4	0.9	3.0	0.6	0.4	0.8
PT	0.4	3.7	0.2	0.5	0.3	1.8	0.4	0.1
RO	1.0	0.5	0.7	1.1	2.1	0.5	0.3	1.4
SE	0.7	0.2	0.4	0.7	0.6	1.3	1.1	2.9
SI	0.2	0.1	0.0	0.3	4.9	0.0	0.1	0.1
SK	0.8	0.2	0.3	2.9	2.2	0.1	0.4	0.8
UK	2.1	0.3	0.3	2.4	0.2	1.2	1.8	0.5

*Regions of origin are set according to those in the EU-Labour Force Survey country of birth variable, which is used for the modelling of the labour force participation.

**Other Europe refers to European countries not included in the model, such as Russia, Ukraine, Moldova, Belarus, Turkey

Data source: Aristotelous, Smith, and Bijak (2022), visualisation authors

2.2 Modules

The microsimulation model consists of nine modules corresponding to the events that are being modelled. The availability of comparable data for all 31 countries sets limits to the interlinkages that can be captured and incorporated in the model. This is particularly true for the EU-LFS where different countries do not provide some variables or provide them in deferring category break downs, in which case the least granular coding determines the use. Table 1 provides an overview of the simulated events and their determining status variables.

Table 1: Overview of the events modelled in QuantMig-Mic and their determining status variables

Events	*Age*	*Sex*	*Place of residence*	*Place of birth*	*Age at immigration*	*Duration of stay (immigrants)*	*Language*	*Religion*	*Educational attainment*	*Mother' s education*
Fertility	X		X	X	X	X			X	
Mortality	X	X	X						X	
Intra-European migration	X	X	X	X						
Emigration	X	X	X	X						
Educational attainment	X	X	X	X			X	X		X
Labour force participation	X	X	X	X	X	X			X	
Employment	X	X	X	X	X	X			X	
Language used at home					X	X	X			
Religion	X	X	X					X		

The employment module is coded in the model code and can be utilised for more refined labour market integration scenarios alike those by Marois and Potančoková (2020). However, the parameters were not updated with more recent EU-LFS data and would need to be added by the users into the model through the user interface in order to obtain results.

2.2.1 Fertility module

A fertility event initiates a new actor (representing a newborn child) inside the model. QuantMig uses updated age-, country- and education specific fertility rates from the 2023 update of the SSP2 scenario of the Wittgenstein Human Capital projection[16] (KC et al 2023) which vary according to age, country of residence, level of education and projection year. These updated rates

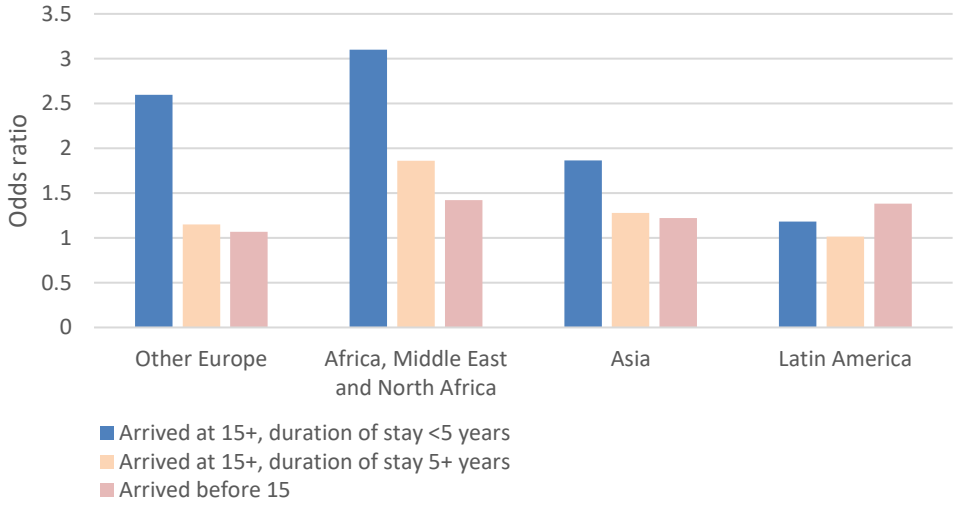
[16] Available at Zenodo: KC et al (2023) Wittgenstein Center (WIC) Population and Human Capital Projections - 2023. https://doi.org/10.5281/zenodo.7921989

take into account unexpected fertility declines in the northern European countries and in France as well as the COVID-19 pandemic impacts for 2020-2024 projection period. Since the contrasted parameters are calculated from a survey in which the population composition differs from the base population in QuantMig-Mic, country-specific calibration factors are calculated to make the number of births matches those reported by Eurostat for 2011-2014 and 2015-2019 separately. The weighted average of these two periods is applied for the rest of the projection.

The age- and education-specific fertility rates are further adjusted to incorporate differentials for native-born and foreign-born women. The age-, country-, and education specific rates are adjusted by contrasted parameters which take into account the place of birth and duration of stay and generation status of women. The version implemented in the QuantMig-Mic is an update of the method explained in Potančoková and Marois (2020). In the updated version, the parameters for being a student are not used anymore as to avoid possibly large discrepancy with the SSP2 scenario fertility rates. The education variable used is the therefore the "current level of education" without distinguishing those who are still at school from those who have completed education. The odds ratios estimated from the EU-LFS 2014-2019 data introduce fertility differentials between native-born and different groups if immigrant women depending on their migrant characteristics (Figure 3). No fertility differentials based on other cultural characteristics are included due to lack of data.

Figure 3 shows the odds of having a child by region of origin, age at arrival and duration of stay used as assumptions.

Figure 3. Odds of having a child* by region of origin, age at arrival and duration of stay, relative to 1 for Born in EU+



* Control for age, education and country of residence

Source: Potančoková and Marois (2020)

2.2.2 Mortality module

The mortality module of QuantMig-Mic is the same as in CEPAM-Mic, with the addition of parameters for new countries (Iceland, Norway and Switzerland). Mortality rates by age, sex and educational attainment are taken from the 2023 update of the SSP2 scenario of the Wittgenstein

Human Capital projection[17] (KC et al 2023). These new mortality assumptions take into account available data on adult mortality by educational attainment, incorporate covid-19 impacts in 2020-2024 and beyond and result in general less rapid life expectancy compared to previous Wittgenstein centre Human Capital projections. Mortality rates vary according to age, sex, country of residence, level of education and projection year. Continuous improvement in life expectancy at birth is assumed with long-term regional convergence, exceeding 90 years in most European countries by 2060. Differentials in life expectancy (at the age of 15) between the low- and the high-educated is based on observed data collected from EUROSTAT and only for counties where no empirical data were published the differential kept constant at about 4 years for females and 6 years for males. No mortality differentials based on ethno-cultural characteristics are included.

2.2.3 Education module

The education module of QuantMig-Mic follows the same methodology as the one of CEPAM-Mic (Marois, Sabourin, and Bélanger 2019a). The highest level of education that an individual will reach over the life course is set probabilistically at birth (or at arrival for immigrants who arrived during childhood) using parameters from an ordered logit regression. The model, based on the European Social Survey data, explicitly considers the influence of personal characteristics and the educational attainment of the mother. Sex- and country-specific cohort parameters are also included and extrapolated to establish assumptions for future cohorts. The model equation is thus formulated as follows:

$$\ln\left(\frac{E_{ij}}{1-E_{ij}}\right) = \beta_{0j} + \beta_{1j}Ct_i + \beta_{2j}Cr_i + \beta_{3j}(Ct_i * Cr_i) + \beta_{4j}X_i + \beta_{5j}Z_i \quad (1)$$

Where

- E_{ij} is the probability that an individual i reaches level of education j, where j equals High or Medium;
- Ct is the country of residence;
- Cr is a discrete variable for birth cohorts (1940-44=1; 1945-49=2, …, 1975-1979=8);
- X is a set of sociocultural variables;
- Z is the highest educational attainment of the mother.

Country-specific cohort trends (β_0 to β_3) are extrapolated over the time span of the projection. This means that we assume continuation of the education expansion into the future. The probability to have a postsecondary education is capped at a maximum of 90%, in accordance to other international projections of educational attainment (Lutz et al. 2018; Lutz, Butz, and KC 2014).

Individuals are set as student starting from age 5 until the age of graduation from the highest completed level (but at most to age 29). The age at graduation is determined for all levels using Eurostat distributions by ISCED-2011 levels for the latest graduated cohorts. The modelling of education thus allows distinguishing, for each individual at each projection step, a) the highest level of educational attainment that will be reached during the life course, b) the current level of education, and c) whether or not the individual is still in schooling.

Parameters used in QuantMig-Mic however differs from the following changes in the ordered

[17] Available at Zenodo: KC et al (2023) Wittgenstein Center (WIC) Population and Human Capital Projections - 2023. https://doi.org/10.5281/zenodo.7921989

logit regression model:

1. Newest rounds of the European Social Surveys, (2016 and 2018) are added in the pooled dataset used to estimate parameters. Parameters in CEPAM-Mic were estimated using waves 2006 to 2014.
2. Data for Norway, Iceland and Switzerland are added in the pooled dataset.
3. The ordered logit model is still disaggregated by sex, but not by the EU-15/New EU Member State (NMS) status anymore. This allows to have more robust and consistent parameters for NMS where the sample size of the immigrant population is low and is unlikely to reflect adequately the behaviour of hypothetical new waves of immigration in the future as assumed in many scenarios developed for the QuantMig project. Parameters for the education of the mother were already about the same between EU15/NMS, so the consequence of this reduced specification is marginal.

The updated parameters are presented in the Table 2.

Table 2. QuantMig-Mic parameters for the education module

	Males				Females			
	Medium		High		Medium		High	
Intercept	2.412	***	0.247		1.360	***	-0.288	*
Education of the mother								
Low	-1.979	***	-1.948	***	-2.132	***	-2.224	***
Medium	-0.696	***	-0.996	***	-0.639	***	-1.166	***
Language								
Other EU official language	0.091		0.139	**	-0.262	***	-0.048	
Other language	-0.667	***	-0.338	***	-0.814	***	-0.509	***
Region of birth								
Other Europe	-0.460	***	-0.639	***	-0.038		0.268	*
North Africa	0.020		0.032		0.043		-0.291	
Other Africa	-0.335	*	0.042		-0.992	***	-0.291	*
Latin America	0.900	***	-0.311	*	0.487	***	-0.303	**
East, South and South East	-0.146		0.238		0.398	**	0.603	***
Near and Middle East	-0.758	***	-0.268		-0.744	***	-0.114	
Cohort	0.133	***	0.033	*	0.203	***	0.116	***
Country								
BE	-1.364	***	0.080		-0.640	***	0.156	
BG	-0.227		0.417	*	0.608	***	0.759	***
CY	-0.919	*	0.417		-0.457		0.117	
CZ	0.999	***	-0.401	*	0.312	*	-0.416	*
DE	1.040	***	0.617	***	0.541	***	0.133	
DK	0.151		0.259		0.351	*	0.685	**
EE	1.063	*	1.161	**	1.285	***	1.436	***
ES	-1.977	***	-0.403	**	-1.815	***	-0.817	***
FI	-0.735	**	0.608	**	0.009		0.804	***
FR	-0.812	***	-0.427	**	-0.429	**	-0.206	
GR	-1.567	***	-0.036		-1.370	***	-0.462	*
HR	-0.011		0.280		-0.410	*	0.152	
HU	-0.400	*	0.062		-0.344	*	-0.199	
IE	-1.622	***	-0.432		-0.683	**	-0.198	
IT	-1.697	***	-0.851	***	-1.316	***	-0.850	***
LT	0.691	*	1.422	***	1.150	***	2.232	***

LV	0.712	*	1.077	**	1.300	***	1.710	***
NL	-0.083		0.944	***	-0.221		0.585	**
PL	-0.177		-0.387	*	0.143		0.048	
PT	-2.981	***	-1.672	***	-2.605	***	-1.292	***
RO	-0.852	***	-0.030		-0.991	***	-0.448	*
SE	-0.266		0.465	*	0.889	***	1.041	***
SI	0.315		-0.367		-0.318		-0.448	
SK	0.730	**	-0.014		0.245		-0.235	
UK	-0.534	**	0.358	*	-0.269	*	0.607	***
CH	0.967	***	0.450	*	0.864	***	-0.117	
IS	0.350		0.243	*	-0.218		0.195	
NO	0.483	*	0.506	*	1.021	***	0.467	*
Cohort*Country								
BE	0.053		0.029		0.057	*	0.062	*
BG	-0.005		-0.108	**	-0.025		-0.064	*
CY	0.094		0.026		0.102		0.106	
CZ	-0.101	**	-0.062	*	0.010		-0.040	
DE	-0.133	***	-0.044	*	-0.023		0.018	
DK	-0.117	**	-0.050		-0.036		-0.040	
EE	-0.182	**	-0.154	**	-0.026		-0.040	
ES	0.069	**	0.118	***	0.151	***	0.211	***
FI	0.028		-0.058		0.081	*	0.007	
FR	0.048		0.074	**	0.075	***	0.095	***
GR	0.098	**	0.070	**	0.170	***	0.161	***
HR	0.030		-0.102	**	0.125	***	-0.023	
HU	0.026		-0.068	*	0.079	**	0.026	
IE	0.098	**	0.136	***	0.099	**	0.143	***
IT	0.051	*	0.072	**	0.110	***	0.125	***
LT	-0.085		-0.138	**	0.037		-0.123	**
LV	-0.152	**	-0.146	**	-0.069		-0.127	**
NL	-0.058	*	-0.032		0.035		0.015	
PL	0.056	*	-0.004		0.125	***	0.037	
PT	0.087	**	0.152	***	0.170	***	0.182	***
RO	-0.012		-0.073	**	0.080	**	0.041	
SE	0.038		-0.034		0.001		-0.050	
SI	-0.095		-0.033		0.058		0.062	
SK	-0.039		-0.085	*	0.092	**	-0.007	
UK	-0.041		0.012		0.001		-0.005	
CH	-0.079	*	0.033		-0.034		0.037	
IS	-0.190		-0.003		-0.001		0.101	
NO	-0.154	***	-0.035		-0.132	***	0.022	
Religion								
Islam	-0.522	***	-0.254	**	-0.574	***	-0.143	
No religion	-0.040	*	-0.026		0.010		0.010	
Other	-0.500	***	0.005		-0.403	***	-0.139	***

*** p<0.0001; ** p<0.01; * p<0.05

2.2.4 Labour force participation module

The labour force participation module follows a similar methodology as what developed for CEPAM-Mic (Marois, Sabourin, and Bélanger 2019b). In short, at the end of each year, the module determines probabilistically whether or not the actor participates in the labour force, i.e. the actor is in state active or in state inactive. Labour force participation is determined purely by individual characteristics of the actor (age, sex, place of birth, etc., see Table 1). Parameters are estimated from sex- logit regressions on a binomial variable representing participation in the labour force using EU-LFS 2014-2019 data (yearly files).

Actors aged less than 15 or 75 or more are considered to be inactive.

The logit model is as follows:

(2) $\text{logit}(P) = \beta_0 + \beta_1 AGE|EDU|COUNTRY|YEAR + \beta_2 IMMIG + \beta_3(IM15 * EDU) + \beta_4(IM15 * COUNTRY)$,

where:

- $\beta_0 + \beta_1$ is a set of parameters capturing the joint effect of age and education on labour force participation rates by country and year.
- β_2 is a set of parameters for an immigration variable (IMMIG) combining place of birth[18], age at arrival and duration with the following categories:
    1. Born in EU / EFTA / UK;
    2. Born elsewhere, arrived before the age of 15;
    3. Born in another European country / North America / Oceania, arrived after the age of 15, duration of stay < 5;
    4. Born in another European country / North America / Oceania, arrived after the age of 15, 5 <= duration of stay < 10;
    5. Born in another European country / North America / Oceania, arrived after the age of 15, 10 <= duration of stay;
    6. Born in North Africa / Middle East, arrived after the age of 15, duration of stay < 5;
    7. Born in North Africa / Middle East, arrived after the age of 15, 5 <= duration of stay < 10;
    8. Born in North Africa / Middle East, arrived after the age of 15, 10 <= duration of stay;
    9. Born in another African country, arrived after the age of 15, duration of stay < 5;
    10. Born in another African country, arrived after the age of 15, 5 <= duration of stay < 10;
    11. Born in another African country, arrived after the age of 15, 10 <= duration of stay;
    12. Born in Latin America, arrived after the age of 15, duration of stay < 5;
    13. Born in Latin America, arrived after the age of 15, 5 <= duration of stay < 10;
    14. Born in Latin America, arrived after the age of 15, 10 <= duration of stay;
    15. Born in Asia, arrived after the age of 15, duration of stay < 5;
    16. Born in Asia, arrived after the age of 15, 5 <= duration of stay < 10;
    17. Born in Asia, arrived after the age of 15, 10 <= duration of stay;
- β_3 is a set of parameters estimating the labour force returns on education for migrants born outside the EU / EFTA / UK / North America / Oceania and who arrived at the age of 15 or above (IM15).
- β_4 is a set of parameters that capture country-specific difference in the integration of immigrants arrived at the age of 15 and over.

The logistic regressions model in QuantMig-Mic differs from CEPAM-Mic in many ways.

1. New waves of the Labour Force Survey are added to the pooled dataset (now going from 2010-2019).
2. The model is not country-specific anymore. Instead, the country is added as a predictor of the labour force participation with relevant interactions with education, age, and place of birth.
3. The immigrant variable now details the place of birth together with the duration of stay, thus allowing to integrate origin-specific integration process.
4. The effect of duration of stay is the same in all countries. This allows to have robust and consistent parameters for countries with small number of immigrants in the survey. Differences in the integration process is captured with a variable interacting the country of residence of the immigrant status (for immigrants arrived at the age of 15 and over).

The estimates of model parameters β_2 are presented in Table 3, showing that the labour force participation rates increase with the duration of stay whatever is the place of birth, that immigrants arrived during childhood have generally higher labour force participation rates than those arrived at the age of 15 and over, and that the integration process is worse for females than for males and varies according to the place of birth.

Table 3: Value of parameters β_2 from equation (2)

Age at immigration	Place of birth	Duration of stay	Males		Females	
NA	Born in EU+	NA	Ref		Ref	
<15	Born outside EU+	All	-0.086	***	-0.289	***
>=15	Born in another European country / North America / Oceania	0-4	-0.544	***	-1.554	***
		5-9	-0.271	**	-1.268	***
		10+	-0.485	***	-0.969	***
	Born in North Africa / Middle East	0-4	-1.85	***	-2.806	***
		5-9	-0.872	***	-2.188	***
		10+	-0.585	***	-1.446	***
	Born in Other Africa	0-4	-1.116	***	-1.516	***
		5-9	-0.585	***	-1.072	***
		10+	-0.178	**	-0.515	***
	Born in Latin America	0-4	-0.91	***	-1.396	***
		5-9	-0.179		-0.771	***
		10+	-0.045		-0.403	***
	Born in Other Asia	0-4	-1.398	***	-2.242	***
		5-9	-0.383	***	-1.665	***
		10+	-0.061		-1.017	***
*** p<0.0001 ; **p<0.01						

The estimates of the parameters β_3 and β_4 are presented in Tables 4 and 5. As a reminder, β_3 is related to the interaction of immigration status (arrived at age 15+) and education level. Because parameters are negatively associated with the education level for both males and females, they reduced the impact of educational attainment on the labour force participation compared to natives and immigrants arrived during childhood. Parameter β_4 is related to the interaction of immigration status (arrived at age 15+) with the country of residence. Since there is a large variation in parameters among countries, they add to the model country-specific dynamics of integration of immigrants in the labour force participation.

Table 4: Value of parameters β_3 from equation (2)

Education level	Males		Females	
Low	0.583	***	0.426	***
Medium	0.270	***	0.314	***
High	Ref		Ref	
*** p<0.0001 ; **p<0.01				

Table 5: Value of parameters β_4 from equation (2)

Country	Males		Females	
AT	-0.192	*	-0.097	
BE	-0.132		-0.134	*
BG	-0.038		0.188	
CH	-0.207	*	-0.197	**
CY	0.239		1.328	***
CZ	0.469		0.678	***
DE	-0.145	**	0.081	*
DK	-0.674	***	-0.064	
EE	0.486		0.343	*
ES	0.503	***	0.645	***
FI	-0.192		0.043	
FR	0.211	***	0.100	**
GR	1.208	***	0.927	***
HR	0.234	*	0.483	***
HU	-0.010		0.923	***
IE	-0.196		0.304	**
IS	-0.144		0.578	
IT	0.610	***	0.826	***
LT	0.218		0.749	***
LU	0.319		0.122	
LV	0.405	*	0.407	**
MT	0.247		0.436	
NL	-0.882	***	-0.447	***
NO	-0.361	**	0.149	
PL	0.054		1.019	***
PT	0.281	*	0.347	***
RO	0.042		0.976	
SE	0.230	*	0.009	
SI	0.303		0.325	*
SK	1.628		0.841	
UK	Ref		Ref	
*** p<0.0001 ; **p<0.01; *p<0.05				

For the base probabilities by age, sex, country and educational attainment, future labour force participation rates are calculated following the cohort-development approach. Entry and exit rates, net of the effect of immigration, are estimated by using the parameters β_0 and β_1 in (2), allowing to build an increment-decrement table of labour force participation. Prospective net transition rates from this table are then applied to cohorts in QuantMig-Mic to obtain future labour force participation rates for the native-born population (i.e. the reference category of the regression model). Parameters β_2, β_3 and β_4 are then applied for the immigrant population based on their characteristics. For most countries and most education groups, this translates into an increase in the labour force participation rate over time, as less active older cohorts are gradually replaced by younger cohorts who are already more active.

2.2.5 Migration modules

Figure 4 visualizes the components and the mechanics of the **Mobility (migration) module** in a nutshell. The first step in the Mobility module is to obtain the number of emigrants who leave country i and migrate to either another of the 31 EU+ countries or to the rest of the world (outside EU+). The number of emigrants from a country i is determined by country and place of birth specific emigration rate estimated separately for native-born, born in EU+ and born outside EU+. The basis and the calculation of the emigration rates is explained in more detail in below. Once the emigration flows from a given country is generated, the parameters for the proportion who stay in the EU+ determines which actors emigrate to the rest of the world (terminated actors) and which actors will move to another EU+ country. The proportion of leaving EU is derived from the same Origin-Destination (OD) matrix of median flows by Aristotelous et al (2022) and is country and place of birth specific. OD matrix determines a new destination country for the actors who move to another European country and remain inside the model. Thus, migration between the 31 European countries is modelled inside the model. Immigrants from other world regions are supplied to the model from an immigration database and enter the model as new actors.

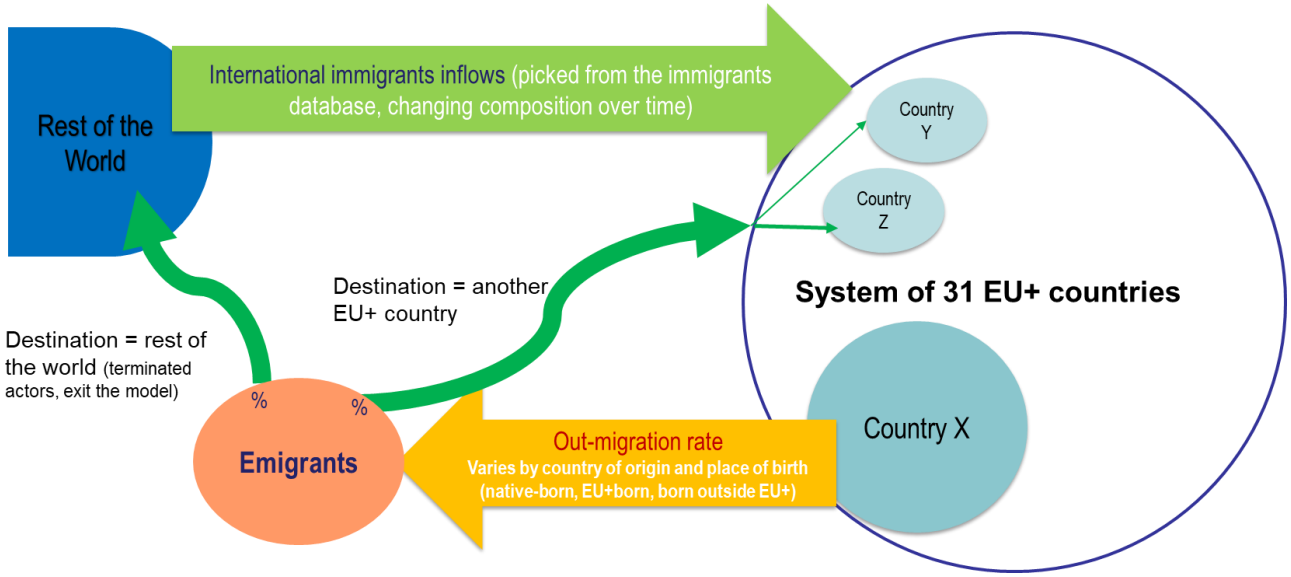
Immigrants from other world regions are supplied to the model from an immigration database and enter the model as new actors. Immigrants in the model are given the same characteristics as recent immigrants in the base population: those who have arrived in the country of residence five years ago or less, as measured in the LFS.

2.2.5.1 Mobility module

Mobility module contains rules and parameters for modelling migration between the 31 countries and from each of these countries in the model to the rest world. The following sets of parameters are used in modelling and their respective values can be modified in the model code:

- Emigration rates (*exit rates* in the model), vary by country or residence and place of birth
- Proportion of emigrants (generated by the gross rate) leaving EU+, varies by country and place of birth
- Out-migration convergence values (targets), varying by place of birth
- Year when the convergence of emigration rates starts
- Duration until the convergence
- Origin-Destination matrix for Intra-EU+ mobility (shares distributing the emigration flow of those who migrate to another EU+ country, into particular countries)
- Migration age schedule

Figure 4. Mobility (migration) modules visualisation



We estimate country-specific emigration rates for native-born, born in EU+ and born outside EU+ in order to capture differential migration intensities among these subpopulations. The numerator, the emigration flows are taken from the OD matrix of median flows from Aristotelous et al. (2022) provided migration flows between 31 European countries (EU+) and between these 31 countries and 8 broad world regions (Other Europe, North Africa, Sub-Saharan Africa, Middle East, South and South East Asia, East Asia, Latin America and Northern America and Australia Oceania) and these flows were available by also by region of birth in two categories: born inside the EU+ and born outside EU+. We have further estimated native-born and born in other EU+ country flows using proportions obtained from register data of Spain, Austria, Italy (35% of native born) for Western European countries and for Eastern European countries, we used the share of native-born among migrants in Romania (95%).

Once we obtained emigration flows from each country separately by simplified place of birth, we calculated country-specific emigration rates among native-born, populations born in EU+ and non-EU+ using estimated emigration flows for each group and the population aged 20-34 in the denominator (Eurostat data). Table 5 shows the estimated emigration rates by country and place of birth. These rates are also applied in pre-simulation (2011-2019). Eastern European countries show higher native-born emigration rates as compared to major destination countries in Western Europe which is partly because of higher migration intensity after their accession into the EU. Because the annual estimates show declining trend in the emigration rates from Eastern European countries, we assume a convergence in native-born and EU+-born emigration rates to the average rate of the destination counties with positive net intra-European migration in 2011-2019. We assume that the native-born emigration rates converge by 2050 to the average of the EU+ countries with positive net migration from intra-EU+ movements. Emigration rates of EU+-born are set to converge in the same manner. This results in declining native-born emigration rate in Eastern and some Southern European counties and mild increases in countries like Italy, France or Germany which have low emigration rates according to our estimates. The emigration rate of persons born outside EU+ does not change during the projection. Emigration flows from the countries in central and eastern Europe to EU+ destinations decline as a combination of lower projected emigration rate of native-born and less populous young age groups due persistent low fertility rates.

Table 5: Estimated initial emigration rates* by country of residence and place of birth from Mobility module

Country	Native-born	Born in EU+	Born outside EU+
AT	2.0%	16.5%	9.4%
BE	1.8%	17.7%	11.3%
BG	6.8%	50.0%	20.0%
CH	3.4%	12.8%	11.1%
CY	3.6%	15.7%	8.3%
CZ	2.4%	4.7%	13.3%
DE	1.5%	21.3%	8.5%
DK	1.6%	16.4%	15.3%
EE	4.2%	10.5%	12.2%
ES	1.8%	20.3%	19.8%
FI	0.8%	25.3%	5.6%
FR	1.3%	29.1%	6.9%
GR	2.2%	55.7%	7.7%
HR	5.5%	14.9%	20.0%
HU	3.8%	5.0%	17.7%
IE	6.2%	18.5%	20.0%
IS	4.0%	27.3%	11.6%
IT	1.2%	25.6%	6.0%
LT	9.7%	50.0%	20.0%
LU	6.6%	15.0%	10.4%
LV	5.7%	49.4%	20.0%
MT	2.5%	31.5%	9.5%
NL	1.4%	19.6%	10.5%
NO	1.5%	14.4%	7.1%
PL	2.7%	55.3%	20.0%
PT	2.7%	54.7%	16.8%
RO	9.9%	50.0%	20.0%
SE	1.2%	19.2%	5.8%
SI	2.7%	6.5%	20.0%
SK	2.8%	9.0%	11.1%
UK	2.2%	12.6%	9.1%

*The country-specific emigration rates have been derived as the number of emigrants born in x from country i divided by the population age 20-34 born in region x living in country i

While emigration rates converge, the proportion leaving EU+ (Table 6) and destinations within EU+ by country of origin of migrants (Table 7) are kept constant throughout the projection.

Table 6: Proportion of emigrants leaving the model, ie. migrating to the rest of the world

Country	Native-born	Born in EU+	Born outside EU+
AT	41%	2%	57%
BE	43%	2%	56%
BG	5%	5%	18%
CH	50%	3%	59%
CY	32%	1%	42%
CZ	23%	23%	64%
DE	62%	4%	75%
DK	46%	2%	60%
EE	8%	8%	31%
ES	54%	3%	72%
FI	38%	2%	47%
FR	67%	5%	76%
GR	39%	2%	52%
HR	14%	14%	39%
HU	14%	14%	43%
IE	65%	5%	76%
IS	22%	1%	34%
IT	27%	1%	40%
LT	10%	10%	34%
LU	11%	0%	17%
LV	19%	19%	50%
MT	26%	1%	34%
NL	50%	3%	62%
NO	33%	1%	45%
PL	20%	20%	52%
PT	51%	3%	62%
RO	10%	10%	28%
SE	42%	2%	58%
SI	26%	26%	55%
SK	3%	3%	12%
UK	67%	5%	79%

Table 7: Destinations (top row) for emigrants migrating into another EU+ country by country of origin

	AT	BE	BG	CY	CZ	DE	DK	EE	ES	FI	FR	GR	HR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	UK	CH	IS	NO	total
AT	0.0%	0.6%	2.9%	0.1%	2.4%	32.2%	0.5%	0.1%	2.0%	0.3%	2.1%	1.1%	2.7%	10.9%	0.4%	3.2%	0.1%	0.2%	0.2%	0.1%	1.4%	6.9%	0.7%	11.6%	0.8%	1.4%	5.9%	3.0%	5.8%	0.1%	0.4%	100%
BE	0.8%	0.0%	2.0%	0.1%	0.7%	7.5%	0.7%	0.2%	8.0%	0.4%	28.7%	1.1%	0.3%	1.0%	0.8%	4.0%	0.2%	3.8%	0.2%	0.1%	13.8%	5.2%	3.0%	4.8%	1.0%	0.2%	0.6%	7.8%	2.3%	0.1%	0.5%	100%
BG	4.8%	4.3%	0.0%	1.0%	1.4%	30.5%	1.3%	0.1%	8.2%	0.3%	2.0%	6.6%	0.1%	0.4%	0.3%	7.9%	0.0%	0.1%	0.1%	0.1%	4.0%	1.5%	1.4%	0.9%	0.8%	0.7%	0.4%	19.0%	0.7%	0.1%	1.0%	100%
CY	0.5%	0.8%	6.4%	0.0%	0.8%	6.6%	0.6%	0.2%	1.0%	0.5%	1.2%	13.8%	0.0%	0.7%	1.0%	0.8%	0.9%	0.1%	0.2%	0.1%	1.9%	1.1%	0.2%	2.0%	1.5%	0.1%	0.7%	54.8%	0.8%	0.0%	0.7%	100%
CZ	4.4%	1.1%	1.1%	0.3%	0.0%	23.7%	0.8%	0.2%	3.3%	0.3%	3.1%	1.9%	0.3%	1.7%	1.8%	1.9%	0.1%	0.2%	0.2%	0.1%	1.7%	4.8%	0.4%	1.7%	1.0%	0.1%	27.1%	13.9%	1.9%	0.4%	0.7%	100%
DE	10.0%	1.6%	2.3%	0.2%	2.2%	0.0%	1.5%	0.2%	5.5%	0.5%	7.0%	7.0%	1.6%	3.3%	1.4%	6.0%	0.6%	0.9%	0.5%	0.1%	5.2%	11.8%	3.2%	3.1%	1.7%	0.4%	1.3%	10.1%	9.7%	0.1%	0.9%	100%
DK	1.0%	1.3%	1.8%	0.1%	1.1%	12.7%	0.0%	0.5%	5.0%	1.9%	4.1%	0.8%	0.3%	1.6%	0.8%	3.0%	3.3%	0.3%	1.5%	0.2%	2.7%	8.2%	1.1%	5.9%	13.7%	0.2%	1.0%	8.8%	1.8%	3.6%	11.9%	100%
EE	0.9%	1.1%	0.4%	0.1%	0.7%	9.7%	1.6%	0.0%	2.7%	45.4%	1.9%	0.2%	0.1%	0.3%	2.4%	1.6%	0.5%	0.3%	1.9%	0.1%	1.8%	0.7%	0.4%	0.2%	5.6%	0.1%	0.3%	12.0%	0.8%	0.2%	6.0%	100%
ES	0.7%	3.1%	4.5%	0.0%	0.5%	11.0%	0.8%	0.1%	0.0%	0.5%	11.5%	0.3%	0.0%	0.5%	0.9%	3.9%	0.5%	0.3%	0.1%	0.0%	2.7%	2.3%	5.1%	28.0%	1.2%	0.0%	0.3%	17.0%	2.8%	0.1%	1.0%	100%
FI	1.3%	1.7%	0.6%	0.2%	0.6%	9.1%	2.8%	14.9%	6.6%	0.0%	3.9%	0.7%	0.1%	0.9%	1.2%	1.8%	0.5%	0.6%	0.5%	0.6%	3.4%	1.8%	0.9%	0.5%	24.9%	0.1%	0.2%	12.2%	2.8%	0.3%	4.2%	100%
FR	0.9%	12.2%	0.7%	0.1%	0.8%	10.9%	0.8%	0.1%	11.6%	0.4%	0.0%	0.9%	0.1%	0.6%	2.8%	7.0%	0.2%	2.4%	0.2%	0.2%	3.0%	1.8%	5.0%	2.5%	1.3%	0.1%	0.3%	20.8%	11.4%	0.1%	0.8%	100%
GR	1.7%	2.1%	7.9%	2.6%	1.0%	42.1%	0.7%	0.1%	1.4%	0.5%	2.5%	0.0%	0.0%	0.6%	0.3%	2.1%	0.1%	0.4%	0.1%	0.1%	4.5%	2.3%	0.2%	3.2%	3.7%	0.0%	0.4%	16.1%	2.0%	0.1%	1.2%	100%
HR	12.5%	1.1%	0.2%	0.0%	0.7%	60.8%	0.7%	0.0%	0.5%	0.1%	0.7%	0.1%	0.0%	0.8%	1.2%	4.8%	0.0%	0.3%	0.0%	0.0%	1.0%	0.4%	0.1%	0.3%	2.9%	4.8%	0.8%	2.2%	1.4%	0.2%	1.4%	100%
HU	19.6%	1.2%	0.2%	0.2%	1.3%	28.4%	1.1%	0.1%	2.9%	0.4%	1.7%	0.8%	0.3%	0.0%	1.8%	2.4%	0.0%	0.3%	0.1%	0.1%	3.3%	1.3%	0.4%	7.2%	1.5%	0.2%	5.1%	14.2%	2.9%	0.1%	0.8%	100%
IE	0.6%	0.9%	0.3%	0.1%	1.0%	7.5%	0.7%	0.5%	4.7%	0.3%	7.4%	0.4%	0.2%	1.2%	0.0%	2.2%	4.8%	0.2%	2.3%	0.1%	2.2%	11.8%	1.0%	2.5%	1.0%	0.0%	1.6%	42.9%	1.1%	0.1%	0.4%	100%
IT	2.2%	2.9%	1.1%	0.1%	0.6%	20.4%	0.6%	0.1%	7.5%	0.3%	11.0%	0.4%	0.6%	0.6%	1.7%	0.0%	0.1%	1.0%	0.1%	0.7%	2.0%	2.4%	0.8%	14.8%	1.0%	0.4%	0.6%	18.6%	7.1%	0.0%	0.5%	100%
LT	0.4%	0.6%	0.1%	0.4%	0.2%	9.8%	3.0%	0.2%	2.5%	0.4%	0.8%	0.3%	0.0%	0.0%	9.9%	1.2%	0.0%	0.2%	0.5%	0.1%	1.9%	0.5%	0.2%	0.0%	3.0%	0.0%	0.0%	52.3%	0.4%	1.0%	10.2%	100%
LU	1.6%	16.3%	0.2%	0.1%	0.3%	15.0%	1.1%	0.2%	3.2%	0.5%	31.3%	1.2%	0.1%	0.6%	0.8%	4.2%	0.2%	0.0%	0.1%	0.0%	2.9%	1.2%	8.1%	0.3%	1.2%	0.2%	0.4%	4.9%	3.1%	0.4%	0.3%	100%
LV	1.3%	1.2%	0.3%	0.2%	0.5%	11.5%	3.0%	2.1%	1.9%	1.6%	1.4%	0.3%	0.0%	0.4%	9.3%	2.1%	1.4%	0.1%	0.0%	0.0%	3.8%	1.7%	0.2%	0.1%	4.3%	0.0%	0.4%	41.1%	1.0%	1.3%	7.5%	100%
MT	0.6%	1.4%	1.3%	0.2%	0.5%	7.4%	1.3%	0.1%	2.0%	1.2%	5.2%	0.7%	0.1%	0.7%	1.6%	7.4%	0.4%	0.2%	0.2%	0.0%	2.7%	0.7%	0.5%	0.6%	3.4%	0.1%	0.7%	56.3%	1.5%	0.1%	0.8%	100%
NL	1.4%	15.1%	2.0%	0.2%	0.9%	19.9%	1.3%	0.2%	7.2%	0.6%	6.0%	1.7%	0.3%	1.9%	1.3%	3.0%	0.7%	0.5%	0.5%	0.2%	0.0%	10.7%	2.2%	1.9%	2.2%	0.1%	0.6%	13.7%	2.4%	0.1%	1.3%	100%
PL	3.1%	2.8%	0.3%	0.1%	1.2%	33.1%	1.8%	0.0%	1.7%	0.3%	1.8%	1.1%	0.1%	0.4%	4.4%	3.5%	0.1%	0.2%	0.2%	0.0%	8.4%	0.0%	0.1%	0.3%	2.7%	0.0%	0.7%	23.3%	1.4%	1.3%	5.6%	100%
PT	0.9%	4.6%	0.7%	0.0%	0.2%	19.0%	0.7%	0.1%	10.6%	0.2%	17.5%	0.2%	0.0%	0.3%	0.9%	1.6%	0.1%	2.9%	0.1%	0.0%	3.2%	0.3%	0.0%	1.3%	0.7%	0.0%	0.2%	19.8%	12.7%	0.3%	1.0%	100%
RO	5.9%	3.9%	0.2%	0.2%	0.4%	7.1%	1.3%	0.0%	14.1%	0.2%	2.8%	1.3%	0.0%	2.0%	1.0%	41.5%	0.0%	0.0%	0.0%	0.0%	1.3%	0.3%	0.5%	0.0%	0.9%	0.0%	0.8%	12.8%	0.6%	0.1%	0.7%	100%
SE	1.0%	1.1%	0.6%	0.3%	0.6%	9.0%	12.1%	0.8%	5.8%	9.9%	3.9%	1.4%	0.4%	1.1%	0.9%	1.8%	1.1%	0.3%	0.6%	0.6%	2.9%	5.0%	1.5%	1.4%	0.0%	0.1%	0.3%	12.9%	2.5%	1.7%	18.4%	100%
SI	22.8%	1.9%	4.0%	0.1%	0.8%	25.3%	0.5%	0.1%	1.4%	0.3%	1.9%	0.2%	14.6%	0.9%	0.5%	5.8%	0.1%	0.7%	0.0%	0.1%	1.8%	0.7%	0.3%	1.0%	1.2%	0.0%	1.3%	5.2%	5.9%	0.1%	0.5%	100%
SK	18.1%	1.5%	0.3%	0.1%	34.4%	12.0%	1.3%	0.1%	1.3%	0.2%	1.3%	0.3%	0.3%	2.5%	1.8%	3.4%	0.0%	0.2%	0.1%	0.1%	2.3%	0.9%	0.1%	0.4%	0.6%	0.4%	0.0%	10.4%	3.9%	0.3%	1.5%	100%
UK	0.8%	1.2%	2.1%	1.8%	1.3%	9.6%	1.4%	0.3%	11.5%	0.6%	12.0%	2.5%	0.1%	1.7%	8.3%	4.4%	4.3%	0.3%	1.5%	0.7%	3.4%	12.0%	3.2%	7.1%	2.1%	0.1%	1.9%	0.0%	2.3%	0.2%	1.1%	100%
CH	3.3%	1.3%	0.4%	0.1%	0.9%	25.7%	0.8%	0.1%	6.3%	0.6%	17.8%	0.8%	0.7%	1.7%	0.6%	11.3%	0.1%	0.4%	0.1%	0.1%	2.0%	2.4%	9.7%	1.3%	1.4%	0.3%	1.1%	7.9%	0.0%	0.1%	0.5%	100%
IS	0.7%	0.5%	0.2%	0.1%	1.0%	4.9%	16.6%	0.3%	2.9%	1.0%	1.4%	0.1%	0.1%	0.6%	0.4%	0.8%	2.9%	0.4%	1.3%	0.1%	1.6%	17.6%	1.4%	0.5%	15.7%	0.1%	0.9%	5.7%	1.4%	0.0%	19.0%	100%
NO	0.5%	0.8%	0.7%	0.1%	0.6%	6.2%	10.6%	1.2%	4.6%	2.0%	2.8%	0.4%	0.2%	0.7%	0.4%	1.1%	6.4%	0.1%	1.6%	0.1%	2.3%	14.8%	0.7%	1.5%	24.3%	0.1%	1.1%	10.3%	1.1%	2.6%	0.0%	100%

2.2.5.2 Immigration module

The international immigration module adds international immigrants into the model. The immigrant flows from the rest of the world are actors entering the model and, therefore, a separate module is coded for the immigration event into the EU+ countries from the eight rest of the world regions. Immigrant population database, available from the Zenodo repository, and sampling rules for immigrants regulate immigration events. Immigrants are loaded from the database into "Immigration Pop" and "Immigration" stores the sampling rules for case generation (these rules are the same as for base population). The immigrant actors have predefined characteristics, such as sex and age and educational attainment. This module is deterministic, and assumptions concerning immigrant's population composition and the geographic distribution are set a priori. Each scenario presented this report has different assumptions concerning the number of international immigrants by region of birth, which are detailed in the next section.

Educational composition of international immigrants is inferred from the foreign-born population age 20 and over and arrived in the country at the of age 20 and above in the EU-LFS 2010-2019. Despite pooling many waves, the sample size was still very small for many specific subgroups, yielding in very large inaccuracy or even completely missing population. Therefore, to have consistent education estimates for all possible profiles of immigrants, we calculated proportions from multinomial logit regression parameters with the following model specification:

$$(3)\ \text{logit}(edu) = \beta_0 + \beta_1 COUNTRY + \beta_2 PERIOD + \beta_3(SEX|\text{COHORT}) + \beta_4(SEX|\text{REGION OF BIRTH}) + \beta_5(\text{REGION OF BIRTH}|\text{COHORT})$$

Assuming continuation of past trends observed in the immigrant population living in Europe, parameters for the cohort variable allow forecasting the educational attainment of future waves of immigrants by sex and place of birth. Due to the small counts of the resulting migrant groups, other interactions or breakdowns could not be included. The immigration population database for all scenarios is stored in separate dataset and accessible in the Zenodo repository (Potančoková et al. 2023b).

2.2.6 Religion and language spoken at home modules

These modules are identical to the ones in CEPAM model. At birth, religious affiliation and language spoken at home are taken directly from the mother, and are subsequently allowed to change during the life course. Transition rates for religious denomination were taken directly from the PEW projections on religion (Pew Research Centre 2015). Life course transition rates for language spoken at home were based on model schedules (Sabourin and Bélanger 2015) calibrated using data from the ESS. The socio-cultural variables are used to model educational transmission and to capture differentials in educational attainment on top of place of birth. We do not foresee additional work on these modules due to lack of data.

3. Migration scenarios

The scenarios presented in this report vary with respect to their assumptions on international immigration, predominantly in terms of the numbers of international immigrants (flows) from the rest of the world regions into the EU+ countries. As explained in the workings of the Mobility module in Section 2.2, the implications of varying the assumed immigration flows are reflected in the projected number of emigrants born outside the EU+. Higher immigration from the rest of the world also means that more persons born outside the EU+ move between the countries in EU+ system. For other model components (fertility, mortality, education, labour force participation) all scenarios share the same assumptions at the individual level. However, since the place of birth is a source of heterogeneity for demographic behaviours, assumptions made on immigration impact aggregated components (total fertility rate, total labour force participation, etc.), hence the variation in the resulting rates and number of events in different migration scenarios.

When conceptualising and formulating migration scenarios, the COVID-19 pandemic was leaving its trace on international migration (González et al. 2023) and the war against Ukraine erupted in February 2022, immediately profoundly changing migration flows from Eastern Europe into the EU+ countries. The number of displaced Ukrainians who crossed EU borders exceeded by far the number of Syrian and Iraqi refugees who arrived in 2015-2016. The experiences of past high migration events into EU+ have confirmed that we need to set migration assumptions with respect to origin countries and regions rather than for gross immigration flow into the EU+ from the rest of the world. As previously mentioned, country groupings were limited by the EU-LFS definition of regions of birth, so we could not model country-specific flows, also due to data limitations.

As we expected, the impacts of COVID-19 pandemic on immigration into the EU+ were the most severe in 2020. According to Eurostat, the number of immigrants in most European countries in 2021 increased as compared to 2020[19], with further increases expected in 2022. Therefore, with the outlook until 2025 we would not expect large reductions in average number of immigrants as compared to 2015-2019 period. Inflow of Ukrainian refugees (more formally: people seeking asylum or temporary protection, although we will be using these terms interchangeably) in the main countries of destination far exceeded the average volumes. Thus, all simulated scenarios share the same immigration assumptions for 2020-2024 and the scenarios only diverge from 2025-2029. Exact numbers of immigrants and emigrants for the first projected period 2020-2024 may slightly differ between individual scenarios because of Monte Carlo random process.

We have simulated altogether 29 scenarios. The baseline scenario serves as a benchmark to which scenarios of high migration events with and without persistence and from different world regions can be compared to and their impacts assessed. Below we first summarise the main assumptions and the operationalisation of the baseline scenario and then explain the modelling and the implementation of the alternative scenarios simulating migration events into the EU+. All simulations have a horizon of 2060, but alternative migration scenario are implemented in 2025-2029 for short events and for periods 2025-29 to 2035-39 for migration events with persistence. Migration scenarios are designed for the evaluation of long-term demographic and labour force impacts of different migration assumptions and serve as sensitivity analysis of implications of immigration from different world regions into the EU+ and of different magnitudes.

[19] Table t_migr_immi: https://ec.europa.eu/eurostat/databrowser/view/TPS00176/default/table?lang=en

3.1.1 Baseline scenario

In population projections, the baseline (sometimes called 'medium') scenario normally represents a business-as-usual situation, with the past trends continuing. In our case, the trends in international immigration observed in 2011-2019 are therefore assumed to continue until 2060. Immigration from the rest of the world regions into the EU+ countries continues with the same intensity as in the second decade of 21st century and immigrants from the eight world regions will be attracted mainly towards those EU+ countries where compatriots from that given region have already migrated to in the past, and where the existing migration networks can therefore support them. We also assume that the war against Ukraine will continue beyond 2023 and the combat will cease by 2025, resulting in return of 60% of the refugees back to Ukraine[20]. This baseline inflow (without the additional immigration of refugees from Ukraine) has been derived by applying the average emigration rate into the EU+ country from Other Europe.

Actual immigration volumes from eight world regions used in the projection countries have been derived by applying the average *emigration rate from each world region into the EU+* for 2011-2019 onto projected population sizes in the world regions. The emigration rates for the world regions have been calculated by taking average median immigration flows into the EU+ in 2011-2019 as estimated by Aristotelous et al (2022), with a correction for Germany, and population exposures (population age 20-34) for each world region from the Wittgenstein data explorer (Wittgenstein Centre for Demography and Global Human Capital 2018)[21] from the SSP2 scenario and the back-projections. The obtained average emigration rates were then applied onto estimated mid-year population counts of 20-34-year olds in each world region from the zero migration SSP2 scenario of the Wittgenstein Centre Human Capital Projections (Wittgenstein Centre for Demography and Global Human Capital 2018). The average annual emigration flows from each world region and projection period were then multiplied by 5 to obtain total number of immigrants for each 5-year period. The resulting immigration flows (including the correction for refugee migration from Ukraine in 2020-24 are presented in Table 8. The projected immigration flows from Other Europe region for 2020-2024 are triple the than the projected flow derived from the average emigration rate in 2025-2029. The overall immigration into the EU+ from the rest of the world in 2020-24 is thus by 25% higher than the projected values for 2025-2029.

Setting assumptions separately by region of birth has helped us to better capture and adjust the immigration flows from Other Europe with the information on refugees registered in EU+ countries available by the end of January 2023, We have collected the data on total number of Ukrainian nationals seeking protection in each EU+ country, as reported by the UNHCR data portal (https://data.unhcr.org/en/situations/ukraine) on 6th February 2023 (the reporting dates varied for individual reporting countries) summing up to the total of 4.894.428 refugees or people having a temporary protection status in EU+. There is of course great uncertainty regarding returns, onward migration and also future immigrants to come during the ongoing conflict. We thus assume that the war will end by 2025, and we assume that 40% will stay in the EU+ (net inflow) although we are aware there this would depend on country-specific policies regarding their legal status and options

[20] We apply net inflows of Ukrainian refugees and add them into the immigration flows for Other Europe region for 2020-2024 period only.

[21] Population counts downloaded from the zero migration SSP2 scenario by country, Wittgenstein Centre Human Capital Data Explorer http://dataexplorer.wittgensteincentre.org/wcde-v2/ , last visited March 2021.

for renewing residence permits at the time of the end of the conflict. We have also tried to collect any information on what share of refugees from ex-Yugoslavia returned after the end of war in 1995, as this situation would be somewhat similar and potentially illustrative, however, cohort-based data on such returns were not reported in any statistics or research papers, leaving us will the expert estimate to set the net flow over a longer term.

Table 8: Assumed total immigration flows from the world regions into the EU+ for all projection periods, baseline scenario

Total immigration from:	2020-24	2025-29	2030-34	2035-39	2040-44	2045-49	2050-54	2055-59
Other Europe	5,140,112	1,669,511	1,699,076	1,805,692	1,801,092	1,662,969	1,483,465	1,365,750
North Africa	929,664	965,206	1,053,874	1,161,001	1,222,826	1,218,038	1,181,374	1,163,108
Sub-Saharan Africa	1,659,728	1,961,478	2,143,433	2,402,594	2,619,129	2,786,751	2,926,193	3,062,040
West Asia	1,465,786	1,491,034	1,575,084	1,674,694	1,729,596	2,040,755	1,700,498	1,677,060
South & South-East Asia	2,074,641	2,123,791	2,154,011	2,159,123	2,146,626	2,112,087	2,070,893	2,016,878
East Asia	832,160	734,951	711,126	704,760	673,467	613,848	547,250	496,276
Latin America	1,871,965	1,868,969	1,845,690	1,823,424	1,850,264	1,818,550	1,719,318	1,654,183
North America + Oceania	1,298,363	1,035,354	1,005,251	995,669	992,730	988,946	979,947	960,490
Total into EU+	**15,272,419**	**11,850,294**	**12,187,544**	**12,726,958**	**13,035,730**	**13,241,945**	**12,608,937**	**12,395,784**

The estimated net inflow of Ukrainian refugees was then added as additional inflow to the immigration the inflow resulting from baseline assumptions for Other Europe region of birth (detailed in the section below) for 2020-2024. We have also compared the distribution of Ukrainian refugees in EU+ countries to the distribution of person from Other Europe region and the comparison confirmed that these greatly overlap, supporting the argument on the key role of the existing migration networks as important factors for destination choice (Massey et al. 1993).

We used emigration rate from the world regions to derive projected immigration flows into the EU+ because the migration decisions are made in the countries of origin. As young adults normally have the highest propensity to migrate, we wanted to capture the potential impacts of diverging projected demographic dynamics in different word regions on potential number of migrants. Thus, the projected immigration volumes from demographically growing and young regions increase towards 2060, for example the projected number of immigrants from Sub-Saharan Africa nearly doubles between 2020-24 and 2055-59, followed by 25% increase for immigration from Northern Africa and 14% increase from West Asia. In contrast, immigration volumes from regions with ageing populations, i.e. older age structures in the future as compared to 2020, reflect this relatively declining pool of highly-mobile young adults. East Asia is a good example, with the projected immigration declining by 40% between 2020-24 and 2055-59. These projected declines reflect only the expected future change in population sizes and age structures and disregard impact of other migration drivers.

The gross flows presented in Table 8 have been further disaggregated by country of destination according to the proportions of destinations for each world regions of origin. For example, the same share of immigrants into the EU+ from Latin America would be destined into Spain in the projection as was the share from all Latin American immigrants in 2011-2019, and so on. The resulting country-specific immigration flows by region of birth, country of destination and

the projection period are presented in Appendix B. Immigrants are assigned demographic and socio-economic characteristics as explained in section 2.2.5.2. The resulting immigrant population database is available in the Zenodo repository (Potančoková et al. 2023b).

3.1.2 Alternative scenarios of migration events into the EU+

For longer horizons, migration cannot be reasonably accurately predicted (Barker and Bijak 2021), but long-term outlook is needed, given the strong and long-lasting momentum of demographic processes. Political crises, economic downturns as well as human-made and natural disasters can set large numbers of people on the move, just as we have seen in 2015–2016 for migration from Syria or in 2022 from Ukraine. Such events are impossible to foresee in terms of their onset, scale, duration and in terms of how many people will return or settle in what destinations (Bijak and Czaika 2020).

Although violence and war and proximity to Europe seem to matter, however, migration drivers are complex and future conflicts unpredictable. While some events trigger large migration waves towards Europe, others, such as the Taliban's return to power in Afghanistan in 2022 did not result in high immigration into Europe in its aftermath, despite concerns among the policy makers at the beginning of the crisis. This unpredictability of the drivers and their effects on actual migration towards Europe nudges us to take a different approach.

To illustrate the implications of potential high immigration events, we have developed a set of model-based scenarios anchored in statistical modelling and theory of extreme values (Bijak 2023). Although the policy makers may prefer easily-interpretable narrative scenarios, illustrating examples of high-impact migration events from specific countries, we have refrained from pursuing this approach. Quantification of narratives remains challenging due to limits in modelling of future predictors (migration drivers and their complex environments, Czaika et al. 2021) while avoiding oversimplification. Narrative approaches, such as those pursued in the QuantMig vignette study (Boissonneault et al. 2022), must necessarily simplify this complexity into a manageable number of dimensions, leaving modelers with the challenge of translating expert knowledge about a specific migration corridor or flow to other situations.

Although we cannot predict when and where the next crisis will develop and predict how it would impact immigration into Europe, we can simulate such situations in scenarios to inform greater preparedness and contingency planning by outlining the potential impacts. The impacts will depend not only on the magnitude (how many migrants will come), but also on their regions of origin, which differ in terms of the characteristics of their populations (who will come). Both when and where from are hard to predict even in short-term, but once signal data are available migration events can be nowcast (Barker and Bijak 2022). Our scenarios simulate high migration events that differ in term of origin of the immigration, the magnitude and the duration. This modelling means we have to make a decision about:

1) When would the migration event happen
2) What would be its magnitude
3) How long would the event last
4) Where would the immigrants come from the selected seven world regions[22]

[22] All world regions except for North America & Oceania.

For the timing of the event, for simulation purposes we choose period of 2025-2029. As mentioned above, we have already seen a large immigration event to Europe in 2015-2016, and in 2022-2023, and we look ahead to sometime in 2025-2029.

With respect to the magnitude, we pioneer the use of quantiles from Pareto distribution corresponding to once-in-a-decade and twice-in-a century frequency of occurrence of the migration event (Bijak 2023). Bijak's statistical estimates are informed by the past immigration flows from eight world regions into EU+. For the scenario setting we have selected posterior means of the quantiles $q_{0.9}$ (corresponding to once-in-a-decade frequency of occurrence) and $q_{0.98}$ (corresponding to twice-in-a-century frequency of occurrence) from the Pareto distributions fitted to the median QuantMig flow estimates for 2009–2019 (Aristotelous et al. 2022), with corrections related to German immigration manually added for 2015–2019 described in the section 2.2.5. The modelled values are presented in Table 9, simplified from Table 2 in Bijak (2023). Naturally, once in a decade event would bring much smaller number of immigrants than once in a century event. Rare events can be modelled with heavy-tailed distributions and for our purposes we choose Pareto distribution. Once-in-a-decade migration event would then correspond to 90th percentile of this distribution and once-in-a century event to 98th percentile of that same distribution. We term the events of once-in-a-decade frequency of occurrence "migration events" and those with twice-in-a-century frequency of occurrence "high migration events".

Table 9: Annual average immigration into the EU+ system, 2009–19, and the Pareto distribution quantiles corresponding to rare (once-in-a-decade and twice-in-a-century) events

Immigration from:	Pareto q_{90} (once-in-a-decade)	Pareto q_{98} (twice-in-a-century)
East Asia	290,973	434,868
Latin America	639,134	1,118,823
North Africa	322,715	516,837
Other Europe	790,758	1,318,817
South-Southeast Asia	645,593	973,279
Sub-Saharan Africa	549,965	936,962
West Asia	507,621	1,173,796
Total Rest of the World*	**4,110,944**	**7,032,106**

*The sums differ to those given in Bijak (2023) because we do not use estimates for North America and Oceania region as we do not formulate migration scenarios for this migration corridor.

Source: Bijak (2023, Table 2)

Next, with respect to duration of an immigration event we simulate two contrasting situations. First, we suppose a duration of a single year – an one-off influx of immigrants corresponding to "immigration event" and "high immigration event" in magnitude. After one calendar year the migration goes back to normal and projected immigration follows the baseline scenario. Note that we model short migration events sequentially by region of origin. In practice this means that projected immigration flows add the annual average immigration values only for one region and immigration from other world regions is set to the baseline assumptions. In scenarios we alternate regions of origin of immigrants. We take the assumed in the baseline scenario flows for 2025-29 and top it up with additional immigration resulting from an immigration event.

The second situation envisages that higher numbers of immigrants would be arriving during the decade after a high-migration event has taken place as a result of chain migration, family reunifications, established migration networks or prolonged crisis that gave rise to migration event in the first place. In other words, same as in the short immigration events, we suppose that this event will take place in 2027 and that for next 10 years immigration from that same origin would keep arriving to Europe, albeit in ever smaller numbers compared to those who arrived in the first year. After ten years, the additional migration 'wave' vanishes and immigration flows return to levels observed in the baseline scenario. We term this set of scenarios "persistent migration events".

To sum up, at this point we have four sets of migration events to simulate: short once-in-a-decade migration events form 7 world regions, once-in-a-decade events from 7 world regions with persistence, short twice-in-a-century events from 7 world regions, and twice-in-a-century events from 7 world regions with persistence.

Table 9 summarises the 28 scenario combinations.

Table 9: Assumption setting for the 28 scenarios of migration events into the EU+

	short event from:	**event followed by persistence from:**
Once-in-a-decade immigration	Other Europe	Other Europe
	North Africa	North Africa
	Sub-Saharan Africa	Sub-Saharan Africa
	West Asia	West Asia
	South & South-East Asia	South & South-East Asia
	East Asia	East Asia
	Latin America	Latin America
Twice-in-a-century immigration	Other Europe	Other Europe
	North Africa	North Africa
	Sub-Saharan Africa	Sub-Saharan Africa
	West Asia	West Asia
	South & South-East Asia	South & South-East Asia
	East Asia	East Asia
	Latin America	Latin America

Short high-migration events

Short high-migration events are immigration events from a given region into the EU+ counties with the *frequency of occurrence twice-in-a-century* (taking the modelled immigration corresponding to 98th quantile of Pareto distribution, Bijak 2023). Such events take place for one calendar year within the 5-year period 2025-2029. Immigration from all other world regions follows the baseline scenario. Before and after the extreme event immigration from the given region returns to the levels of the baseline scenario. Such an event can be an outcome of humanitarian or natural disasters with temporary migration and high probabilities of return which can be resulting from a speedy policy reaction to the crisis that provoked high immigration. We modelled seven short high-migration event scenarios corresponding to the seven regions of origin: Other Europe, North Africa, Sub-Saharan Africa, Latin America, West Asia, South & South-East Asia, and East Asia.

Short migration events

A short migration event is an event from a given region with the *frequency of occurrence once-in-a-decade* (taking immigration flows corresponding to the 90th quantile from Pareto distribution), and this event takes place for 1 year within the 5-year period 2025-30. After this immigration event, immigration returns to those levels of the baseline scenario. We modelled seven short high-migration event scenarios corresponding to the seven regions of origin: Other Europe, North Africa, Sub-Saharan Africa, Latin America, West Asia, South & South-East Asia, and East Asia.

Persistent high-migration events

Persistent high-migration events are those where the initial short high-migration event from a given region, corresponding to the frequency of occurrence twice in a century, is followed by gradually diminishing migration inflows from that region for a decade. We simulate this situation by first imposing a "short high-migration event" from a given region in 2027, and then keeping immigration from that region high for a decade, but with the volume of immigrants declining in each subsequent year until it reaches the same values as in the baseline scenario at the end of the decade. The persistence in migration is envisaged because of the initial event's migration network effects, family reunifications and chain migration, as well as due to persistence of migration drivers stimulating out-migration from the origin countries/areas. Elevated migration flows thus take place between 2027 and 2036. In practice, we use interpolated values between the two time points.

Persistent migration events

Identical to the above, but the initial event from a given region has a once-in-a-decade frequency of occurrence. The persistence is also envisaged for a decade following the initial event in 2027. Migration volumes are lower and in practice obtained by interpolating values between the initial event and baseline scenario 10 year later. We modelled seven persistent high-migration event scenarios corresponding to the seven regions of origin: Other Europe, North Africa, Sub-Saharan Africa, Latin America, West Asia, South & South-East Asia, and East Asia.

Table 10 presents an overview of the immigration volumes into the EU+ corresponding to the baseline and 28 scenarios of migration events. Country-specific baseline immigration flows are tabulated in Appendix B of this report. Country-specific immigration flows by scenario and immigrant characteristics are available from the immigrant database which is openly accessible at Zenodo from August 2023 (Potančoková et al. 2023b).

Scenario results, the analysis of demographic and labour force impact and the sensitivity analysis is presented in the discussion paper by Potančoková et al. (2023a).

Table 10: Projected immigration into EU+ in the baseline and migration events scenarios for the periods when migration events are implemented

Scenario		Immigration volumes (millions) 2025-29	2030-34	2035-39
BASELINE		**11.9**	**12.2**	**12.7**
Persistent high-migration event from:	Other Europe	15.4	15.6	13.5
	North Africa	13.3	13.5	12.9
	Sub-Saharan Africa	14.3	14.5	13.0
	West Asia	15.0	15.1	13.1
	South & South-East Asia	14.5	14.6	13.0
	East Asia	13.0	13.3	12.9
	Latin America	14.9	15.0	13.1
Persistent migration event from:	Other Europe	13.6	13.9	12.9
	North Africa	12.8	13.0	12.8
	Sub-Saharan Africa	13.3	13.6	12.9
	West Asia	13.2	13.5	12.9
	South & South-East Asia	13.6	13.8	12.9
	East Asia	12.6	12.9	12.8
	Latin America	13.6	13.8	12.9
Short high-migration event from:	Other Europe	12.8	12.2	12.7
	North Africa	12.2	12.2	12.7
	Sub-Saharan Africa	12.3	12.2	12.7
	West Asia	12.7	12.2	12.7
	South & South-East Asia	12.4	12.2	12.7
	East Asia	12.1	12.2	12.7
	Latin America	12.6	12.2	12.7
Short migration event from:	Other Europe	12.2	12.2	12.7
	North Africa	12.0	12.2	12.7
	Sub-Saharan Africa	11.9	12.2	12.7
	West Asia	12.1	12.2	12.7
	South & South-East Asia	12.1	12.2	12.7
	East Asia	12.0	12.2	12.7
	Latin America	12.1	12.2	12.7

4. Summary

This technical report provides a comprehensive documentation of the QuantMig-Mic microsimulation population projection model for 31 European countries. It details the model architecture, modules, parameters, assumptions, and migration scenarios. The model projects future populations by incorporating differentials in demographic behaviours by place of birth and simulates the impacts of alternative international immigration scenarios. The migration scenarios implement rare migration events to explore the potential long-term impact of migration events from different world regions on the European demographic and labour force dynamics. Migration

scenarios are conceived to explore potential differential impacts of immigration events from different world regions. This approach naturally serves as a sensitivity analysis. The main results are summarised in the deliverable D10.1 (Potančoková et al. 2023a) and results from the high migration events scenarios are visualized through an interactive webtool "QuantMig Scenario Explorer" available at https://www.quantmig.eu as of August. All underlying model data, model code and model outputs from all 29 scenarios are available in Zenodo repository under doi: 10.5281/zenodo.7728049 as of August 2023 (Potančoková et al. 2023b).

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APPENDIX A

Baseline population by country od residence, age, sex, place of birth and educational attainment documentation: data sources and adjustments

Data sources:

Eurostat: Eurostat's CensusHub (https://ec.europa.eu/CensusHub2), last visited March 2021

DIOC: Database on Immigrants in OECD and non-OECD Countries, reference year 2010/11, (DIOC-2011)[23], last visited December 2020

IPUMS: IPUMS-International (https://international.ipums.org/international/), last visited December 2020

NSO: custom data collected from national statistical offices

Missing values: missing age or sex ignored (cases dropped); missing place of birth (unknown) redistributed at random; missing educational attainment proportionally redistributed within the respective age, sex and place of birth category for each country of residence

If population stocks (counts) by age, sex and educational attainment were not available for a given place of birth in the CensusHub (place of birth was limited to native-born, born in another EU country, born outside EU – by continents), we have collected additional data from the DIOC-2011 database, IPUMS or national statistical office to obtain educational distributions. There data were then combined (DIOC data had to be split from 10-year to 5year age groups using proportional fitting). DIOC data or NSO data were also used to obtain data for Turkish-born populations by age, sex and educational attainment and to add these stocks to the Other Europe region because Eurostat's CensusHub data by continents included Turkey in Asia, and to deduct these stocks from Asia before estimating specific subregions of birth within Asia. Same was the case for Croatian-born – these were not included in "born in another EU country" category in the CensusHub, because in 2011 Croatia was not an EU Member State (joined in 2013), We could obtain the counts of Turkish-born and Croatian-born by age and sex from the census hub and these data were then compared to those in DIOC from where we obtained educational compositions. If we could not obtain additional data to estimate educational attainment by place of birth, we used population counts by age, sex and place of birth according to our place of birth definitions combined with educational proportion by age, sex and continent of birth. Final counts are calibrated to each country's age and sex population counts as in CensusHub data.

The table included in this Appendix summarises the main data sources used for each country and different regions of birth, as well as any adjustments made. The resulting dataset available in Zenodo repository under Baseline data files (Potančoková et al. 2023).

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[23] https://www.oecd.org/els/mig/dioc.htm, Methodology: https://www.oecd.org/els/mig/methodology-DIOC-2010-11.pdf

Country	Place of birth	Data sources	Adjustments
Austria	native-born	Eurostat	-
Austria	EU+ born	Eurostat	-
Austria	Other Europe	Eurostat + NSO	born in Europe outside EU and in Turkey, data for Turkish-born by age, sex and education NSO (statcube)
Austria	North Africa	Eurostat	counts for born in North Africa by age and sex, education attainment proportions from Africa
Austria	Sub-Saharan Africa	Eurostat	counts for born in Sub-Saharan Africa by age and sex, education attainment proportions from Africa
Austria	West Asia	Eurostat + NSO	counts for born in West Asia by age and sex, education attainment proportions from Asia (without Turkey)
Austria	South & South-East Asia	Eurostat + NSO	counts for born in S&SE Asia by age and sex, education attainment proportions from Asia (without Turkey)
Austria	East Asia	Eurostat + NSO	counts for born in East Asia by age and sex, education attainment proportions from Asia (without Turkey)
Austria	North America + Oceania	Eurostat	-
Austria	Latin America	Eurostat	-
Belgium	native-born	Eurostat	-
Belgium	EU+ born	Eurostat	-
Belgium	Other Europe	Eurostat + DIOC	born in Europe outside EU and in Turkey, data for Turkish-born by age, sex and education from DIOC
Belgium	North Africa	Eurostat + DIOC	DIOC counts redistribured to 5year age groups
Belgium	Sub-Saharan Africa	Eurostat + DIOC	DIOC counts redistribured to 5year age groups
Belgium	West Asia	Eurostat + DIOC	DIOC counts redistribured to 5year age groups
Belgium	South & South-East Asia	Eurostat + DIOC	DIOC counts redistribured to 5year age groups
Belgium	East Asia	Eurostat + DIOC	DIOC counts redistribured to 5year age groups
Belgium	North America + Oceania	Eurostat	-
Belgium	Latin America	Eurostat	-
Bulgaria	native-born	Eurostat	-
Bulgaria	EU+ born	Eurostat	-
Bulgaria	Other Europe	Eurostat + DIOC	born in Europe outside EU and in Turkey, data for Turkish-born by age, sex and education from DIOC
Bulgaria	North Africa	Eurostat + DIOC	counts for born in North Africa by age and sex, education attainment proportions from Africa
Bulgaria	Sub-Saharan Africa	Eurostat + DIOC	counts for born in Sub-Saharan Africa by age and sex, education attainment proportions from Africa
Bulgaria	West Asia	Eurostat + DIOC	counts for born in West Asia by age and sex, education attainment proportions from Asia (without Turkey)
Bulgaria	South & South-East Asia	Eurostat + DIOC	counts for born in S&SE Asia by age and sex, education attainment proportions from Asia (without Turkey)
Bulgaria	East Asia	Eurostat + DIOC	counts for born in East Asia by age and sex, education attainment proportions from Asia (without Turkey)
Bulgaria	North America + Oceania	Eurostat	-
Bulgaria	Latin America	Eurostat	-

Country	Place of birth	Data sources	Adjustments
Croatia	native-born	Eurostat	-
Croatia	EU+ born	Eurostat	-
Croatia	Other Europe	Eurostat + DIOC	born in Europe outside EU and in Turkey, data for Turkish-born by age, sex and education from DIOC
Croatia	North Africa	Eurostat + DIOC	counts for born in North Africa by age and sex, education attainment proportions from Africa
Croatia	Sub-Saharan Africa	Eurostat + DIOC	counts for born in Sub-Saharan Africa by age and sex, education attainment proportions from Africa
Croatia	West Asia	Eurostat + DIOC	counts for born in West Asia by age and sex, education attainment proportions from Asia (without Turkey)
Croatia	South & South-East Asia	Eurostat + DIOC	counts for born in S&SE Asia by age and sex, education attainment proportions from Asia (without Turkey)
Croatia	East Asia	Eurostat + DIOC	counts for born in East Asia by age and sex, education attainment proportions from Asia (without Turkey)
Croatia	North America + Oceania	Eurostat	-
Croatia	Latin America	Eurostat	-
Cyprus	native-born	Eurostat	-
Cyprus	EU+ born	Eurostat	-
Cyprus	Other Europe	Eurostat + DIOC	born in Europe outside EU and in Turkey, data for Turkish-born by age, sex and education from DIOC
Cyprus	North Africa	Eurostat + DIOC	counts for born in North Africa by age and sex, education attainment proportions from Africa
Cyprus	Sub-Saharan Africa	Eurostat + DIOC	counts for born in Sub-Saharan Africa by age and sex, education attainment proportions from Africa
Cyprus	West Asia	Eurostat + DIOC	counts for born in West Asia by age and sex, education attainment proportions from Asia (without Turkey)
Cyprus	South & South-East Asia	Eurostat + DIOC	counts for born in S&SE Asia by age and sex, education attainment proportions from Asia (without Turkey)
Cyprus	East Asia	Eurostat + DIOC	counts for born in East Asia by age and sex, education attainment proportions from Asia (without Turkey)
Cyprus	North America + Oceania	Eurostat	-
Cyprus	Latin America	Eurostat	-
Czechia	native-born	Eurostat	-
Czechia	EU+ born	Eurostat	-
Czechia	Other Europe	Eurostat + DIOC	DIOC counts redistribured to 5year age groups
Czechia	North Africa	Eurostat + DIOC	DIOC counts redistribured to 5year age groups
Czechia	Sub-Saharan Africa	Eurostat + DIOC	DIOC counts redistribured to 5year age groups
Czechia	West Asia	Eurostat + DIOC	DIOC counts redistribured to 5year age groups
Czechia	South & South-East Asia	Eurostat + DIOC	DIOC counts redistribured to 5year age groups
Czechia	East Asia	Eurostat + DIOC	DIOC counts redistribured to 5year age groups
Czechia	North America + Oceania	Eurostat	-
Czechia	Latin America	Eurostat	-

Country	Place of birth	Data sources	Adjustments
Denmark	native-born	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Denmark	EU+ born	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Denmark	Other Europe	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Denmark	North Africa	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Denmark	Sub-Saharan Africa	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Denmark	West Asia	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Denmark	South & South-East Asia	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Denmark	East Asia	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Denmark	North America + Oceania	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Denmark	Latin America	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Estonia	native-born	Eurostat	-
Estonia	EU+ born	Eurostat	-
Estonia	Other Europe	Eurostat + DIOC	DIOC counts redistribured to 5year age groups
Estonia	North Africa	Eurostat + DIOC	DIOC counts redistribured to 5year age groups
Estonia	Sub-Saharan Africa	Eurostat + DIOC	DIOC counts redistribured to 5year age groups
Estonia	West Asia	Eurostat + DIOC	DIOC counts redistribured to 5year age groups
Estonia	South & South-East Asia	Eurostat + DIOC	DIOC counts redistribured to 5year age groups
Estonia	East Asia	Eurostat + DIOC	DIOC counts redistribured to 5year age groups
Estonia	North America + Oceania	Eurostat	-
Estonia	Latin America	Eurostat	-
Finland	native-born	Eurostat	-
Finland	EU+ born	Eurostat	-
Finland	Other Europe	Eurostat + DIOC	born in Europe outside EU and in Turkey, data for Turkish-born by age, sex and education from DIOC
Finland	North Africa	Eurostat + DIOC	DIOC counts redistribured to 5year age groups
Finland	Sub-Saharan Africa	Eurostat + DIOC	DIOC counts redistribured to 5year age groups
Finland	West Asia	Eurostat + DIOC	DIOC counts redistribured to 5year age groups
Finland	South & South-East Asia	Eurostat + DIOC	DIOC counts redistribured to 5year age groups
Finland	East Asia	Eurostat + DIOC	DIOC counts redistribured to 5year age groups
Finland	North America + Oceania	Eurostat	-
Finland	Latin America	Eurostat	-

Country	Place of birth	Data sources	Adjustments
France	native-born	Eurostat	-
France	EU+ born	Eurostat	-
France	Other Europe	Eurostat + DIOC	born in Europe outside EU and in Turkey, data for Turkish-born by age, sex and education from DIOC
France	North Africa	Eurostat + DIOC	DIOC counts redistribured to 5year age groups
France	Sub-Saharan Africa	Eurostat + DIOC	DIOC counts redistribured to 5year age groups
France	West Asia	Eurostat + DIOC	DIOC counts redistribured to 5year age groups
France	South & South-East Asia	Eurostat + DIOC	DIOC counts redistribured to 5year age groups
France	East Asia	Eurostat + DIOC	DIOC counts redistribured to 5year age groups
France	North America + Oceania	Eurostat	-
France	Latin America	Eurostat	-
Germany	native-born	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Germany	EU+ born	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Germany	Other Europe	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Germany	North Africa	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Germany	Sub-Saharan Africa	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Germany	West Asia	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Germany	South & South-East Asia	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Germany	East Asia	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Germany	North America + Oceania	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Germany	Latin America	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Greece	native-born	Eurostat	-
Greece	EU+ born	Eurostat	-
Greece	Other Europe	Eurostat + DIOC	born in Europe outside EU and in Turkey, data for Turkish-born by age, sex and education from DIOC
Greece	North Africa	Eurostat + DIOC	DIOC counts redistribured to 5year age groups
Greece	Sub-Saharan Africa	Eurostat + DIOC	DIOC counts redistribured to 5year age groups
Greece	West Asia	Eurostat + DIOC	DIOC counts redistribured to 5year age groups
Greece	South & South-East Asia	Eurostat + DIOC	DIOC counts redistribured to 5year age groups
Greece	East Asia	Eurostat + DIOC	DIOC counts redistribured to 5year age groups
Greece	North America + Oceania	Eurostat	-
Greece	Latin America	Eurostat	-

Country	Place of birth	Data sources	Adjustments
Hungary	native-born	Eurostat	-
Hungary	EU+ born	Eurostat	-
Hungary	Other Europe	Eurostat + DIOC	DIOC counts redistribured to 5year age groups
Hungary	North Africa	Eurostat + DIOC	counts for born in North Africa by age and sex, education attainment proportions from Africa
Hungary	Sub-Saharan Africa	Eurostat + DIOC	counts for born in Sub-Saharan Africa by age and sex, education attainment proportions from Africa
Hungary	West Asia	Eurostat + DIOC	counts for born in West Asia by age and sex, education attainment proportions from Asia (without Turkey)
Hungary	South & South-East Asia	Eurostat + DIOC	counts for born in S&SE Asia by age and sex, education attainment proportions from Asia (without Turkey)
Hungary	East Asia	Eurostat + DIOC	counts for born in East Asia by age and sex, education attainment proportions from Asia (without Turkey)
Hungary	North America + Oceania	Eurostat	-
Hungary	Latin America	Eurostat	-
Ireland	native-born		
Ireland	EU+ born		
Ireland	Other Europe	Eurostat + DIOC	born in Europe outside EU and in Turkey, data for Turkish-born by age, sex and education from DIOC
Ireland	North Africa	Eurostat + DIOC	DIOC counts redistribured to 5year age groups
Ireland	Sub-Saharan Africa	Eurostat + DIOC	DIOC counts redistribured to 5year age groups
Ireland	West Asia	Eurostat + DIOC	DIOC counts redistribured to 5year age groups
Ireland	South & South-East Asia	Eurostat + DIOC	DIOC counts redistribured to 5year age groups
Ireland	East Asia	Eurostat + DIOC	DIOC counts redistribured to 5year age groups
Ireland	North America + Oceania	Eurostat	-
Ireland	Latin America	Eurostat	-
Iceland	native-born	Eurostat	-
Iceland	EU+ born	Eurostat	-
Iceland	Other Europe	Eurostat	-
Iceland	North Africa	Eurostat	counts for born in North Africa by age and sex, education attainment proportions from Africa
Iceland	Sub-Saharan Africa	Eurostat	counts for born in Sub-Saharan Africa by age and sex, education attainment proportions from Africa
Iceland	West Asia	Eurostat	counts for born in West Asia by age and sex, education attainment proportions from Asia
Iceland	South & South-East Asia	Eurostat	counts for born in S&SE Asia by age and sex, education attainment proportions from Asia
Iceland	East Asia	Eurostat	counts for born in East Asia by age and sex, education attainment proportions from Asia
Iceland	North America + Oceania	Eurostat	-
Iceland	Latin America	Eurostat	-

Country	Place of birth	Data sources	Adjustments
Italy	native-born	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Italy	EU+ born	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Italy	Other Europe	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Italy	North Africa	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Italy	Sub-Saharan Africa	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Italy	West Asia	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Italy	South & South-East Asia	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Italy	East Asia	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Italy	North America + Oceania	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Italy	Latin America	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Latvia	native-born	Eurostat	-
Latvia	EU+ born	Eurostat	-
Latvia	Other Europe	Eurostat + DIOC	DIOC counts redistribured to 5year age groups
Latvia	North Africa	Eurostat + DIOC	DIOC counts redistribured to 5year age groups
Latvia	Sub-Saharan Africa	Eurostat + DIOC	DIOC counts redistribured to 5year age groups
Latvia	West Asia	Eurostat + DIOC	DIOC counts redistribured to 5year age groups
Latvia	South & South-East Asia	Eurostat + DIOC	DIOC counts redistribured to 5year age groups
Latvia	East Asia	Eurostat + DIOC	DIOC counts redistribured to 5year age groups
Latvia	North America + Oceania	Eurostat	-
Latvia	Latin America	Eurostat	-
Lithuania	native-born	Eurostat	-
Lithuania	EU+ born	Eurostat	-
Lithuania	Other Europe	Eurostat	age and sex as in Eurostat, educational attainment proportions from Latvia
Lithuania	North Africa	Eurostat	age and sex as in Eurostat, educational attainment proportions from Latvia
Lithuania	Sub-Saharan Africa	Eurostat	age and sex as in Eurostat, educational attainment proportions from Latvia
Lithuania	West Asia	Eurostat	age and sex as in Eurostat, educational attainment proportions from Latvia
Lithuania	South & South-East Asia	Eurostat	age and sex as in Eurostat, educational attainment proportions from Latvia
Lithuania	East Asia	Eurostat	age and sex as in Eurostat, educational attainment proportions from Latvia
Lithuania	North America + Oceania	Eurostat	age and sex as in Eurostat, educational attainment proportions from Latvia
Lithuania	Latin America	Eurostat	age and sex as in Eurostat, educational attainment proportions from Latvia

Country	Place of birth	Data sources	Adjustments
Luxembourg	native-born	NSO + DIOC	NSO
Luxembourg	EU+ born	NSO + DIOC	NSO
Luxembourg	Other Europe	NSO + DIOC	DIOC for education proportions, NSO for foreign born counts
Luxembourg	North Africa	NSO + DIOC	DIOC for education proportions, NSO for foreign born counts
Luxembourg	Sub-Saharan Africa	NSO + DIOC	DIOC for education proportions, NSO for foreign born counts
Luxembourg	West Asia	NSO + DIOC	DIOC for education proportions, NSO for foreign born counts
Luxembourg	South & South-East Asia	NSO + DIOC	DIOC for education proportions, NSO for foreign born counts
Luxembourg	East Asia	NSO + DIOC	DIOC for education proportions, NSO for foreign born counts
Luxembourg	North America + Oceania	NSO + DIOC	DIOC for education proportions, NSO for foreign born counts
Luxembourg	Latin America	NSO + DIOC	DIOC for education proportions, NSO for foreign born counts
Malta	native-born	Eurostat	-
Malta	EU+ born	Eurostat	-
Malta	Other Europe	Eurostat + DIOC	born in Europe outside EU and in Turkey, data for Turkish-born by age, sex and education from DIOC
Malta	North Africa	Eurostat + DIOC	counts for born in North Africa by age and sex, education attainment proportions from Africa
Malta	Sub-Saharan Africa	Eurostat + DIOC	counts for born in Sub-Saharan Africa by age and sex, education attainment proportions from Africa
Malta	West Asia	Eurostat + DIOC	counts for born in West Asia by age and sex, education attainment proportions from Asia (without Turkey)
Malta	South & South-East Asia	Eurostat + DIOC	counts for born in S&SE Asia by age and sex, education attainment proportions from Asia (without Turkey)
Malta	East Asia	Eurostat + DIOC	counts for born in East Asia by age and sex, education attainment proportions from Asia (without Turkey)
Malta	North America + Oceania	Eurostat	-
Malta	Latin America	Eurostat	-
Netherlands	native-born	NSO	-
Netherlands	EU+ born	NSO	-
Netherlands	Other Europe	NSO + DIOC	DIOC counts by education adjusted to match NSO counts by age and sex
Netherlands	North Africa	NSO + DIOC	DIOC counts by education adjusted to match NSO counts by age and sex
Netherlands	Sub-Saharan Africa	NSO + DIOC	DIOC counts by education adjusted to match NSO counts by age and sex
Netherlands	West Asia	NSO + DIOC	DIOC counts by education adjusted to match NSO counts by age and sex
Netherlands	South & South-East Asia	NSO + DIOC	DIOC counts by education adjusted to match NSO counts by age and sex
Netherlands	East Asia	NSO + DIOC	DIOC counts by education adjusted to match NSO counts by age and sex
Netherlands	North America + Oceania	NSO + DIOC	DIOC counts by education adjusted to match NSO counts by age and sex
Netherlands	Latin America	NSO + DIOC	DIOC counts by education adjusted to match NSO counts by age and sex

Country	Place of birth	Data sources	Adjustments
Norway	native-born	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Norway	EU+ born	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Norway	Other Europe	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Norway	North Africa	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Norway	Sub-Saharan Africa	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Norway	West Asia	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Norway	South & South-East Asia	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Norway	East Asia	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Norway	North America + Oceania	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Norway	Latin America	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Poland	native-born	Eurostat	-
Poland	EU+ born	Eurostat	-
Poland	Other Europe	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Poland	North Africa	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Poland	Sub-Saharan Africa	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Poland	West Asia	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Poland	South & South-East Asia	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Poland	East Asia	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Poland	North America + Oceania	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Poland	Latin America	DIOC + Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
Portugal	native-born	Eurostat	-
Portugal	EU+ born	Eurostat	-
Portugal	Other Europe	Eurostat + DIOC	born in Europe outside EU and in Turkey, data for Turkish-born by age, sex and education from DIOC
Portugal	North Africa	Eurostat + DIOC	counts for born in North Africa by age and sex, education attainment proportions from Africa
Portugal	Sub-Saharan Africa	Eurostat + DIOC	counts for born in Sub-Saharan Africa by age and sex, education attainment proportions from Africa
Portugal	West Asia	Eurostat + DIOC	counts for born in West Asia by age and sex, education attainment proportions from Asia (without Turkey)
Portugal	South & South-East Asia	Eurostat + DIOC	counts for born in S&SE Asia by age and sex, education attainment proportions from Asia (without Turkey)
Portugal	East Asia	Eurostat + DIOC	counts for born in East Asia by age and sex, education attainment proportions from Asia (without Turkey)
Portugal	North America + Oceania	Eurostat	-
Portugal	Latin America	Eurostat	-

Country	Place of birth	Data sources	Adjustments
Romania	native-born	Eurostat	-
Romania	EU+ born	Eurostat	-
Romania	Other Europe	Eurostat + DIOC	born in Europe outside EU and in Turkey, data for Turkish-born by age, sex and education from DIOC
Romania	North Africa	Eurostat + DIOC	counts for born in North Africa by age and sex, education attainment proportions from Africa
Romania	Sub-Saharan Africa	Eurostat + DIOC	counts for born in Sub-Saharan Africa by age and sex, education attainment proportions from Africa
Romania	West Asia	Eurostat + DIOC	counts for born in West Asia by age and sex, education attainment proportions from Asia (without Turkey)
Romania	South & South-East Asia	Eurostat + DIOC	counts for born in S&SE Asia by age and sex, education attainment proportions from Asia (without Turkey)
Romania	East Asia	Eurostat + DIOC	counts for born in East Asia by age and sex, education attainment proportions from Asia (without Turkey)
Romania	North America + Oceania	Eurostat	-
Romania	Latin America	Eurostat	-
Slovakia	native-born	Eurostat	-
Slovakia	EU+ born	Eurostat	-
Slovakia	Other Europe	Eurostat + DIOC	born in Europe outside EU and in Turkey, data for Turkish-born by age, sex and education from DIOC
Slovakia	North Africa	Eurostat + DIOC	counts for born in North Africa by age and sex, education attainment proportions from Africa
Slovakia	Sub-Saharan Africa	Eurostat + DIOC	counts for born in Sub-Saharan Africa by age and sex, education attainment proportions from Africa
Slovakia	West Asia	Eurostat + DIOC	counts for born in West Asia by age and sex, education attainment proportions from Asia (without Turkey)
Slovakia	South & South-East Asia	Eurostat + DIOC	counts for born in S&SE Asia by age and sex, education attainment proportions from Asia (without Turkey)
Slovakia	East Asia	Eurostat + DIOC	counts for born in East Asia by age and sex, education attainment proportions from Asia (without Turkey)
Slovakia	North America + Oceania	Eurostat	-
Slovakia	Latin America	DIOC	-
Slovenia	native-born	Eurostat	-
Slovenia	EU+ born	Eurostat	-
Slovenia	Other Europe	Eurostat + DIOC	born in Europe outside EU and in Turkey, data for Turkish-born by age, sex and education from DIOC
Slovenia	North Africa	Eurostat + DIOC	counts for born in North Africa by age and sex, education attainment proportions from Africa
Slovenia	Sub-Saharan Africa	Eurostat + DIOC	counts for born in Sub-Saharan Africa by age and sex, education attainment proportions from Africa
Slovenia	West Asia	Eurostat + DIOC	counts for born in West Asia by age and sex, education attainment proportions from Asia (without Turkey)
Slovenia	South & South-East Asia	Eurostat + DIOC	counts for born in S&SE Asia by age and sex, education attainment proportions from Asia (without Turkey)
Slovenia	East Asia	Eurostat + DIOC	counts for born in East Asia by age and sex, education attainment proportions from Asia (without Turkey)
Slovenia	North America + Oceania	Eurostat	-
Slovenia	Latin America	Eurostat	-

Country	Place of birth	Data sources	Adjustments
Spain	native-born	IPUMS	-
Spain	EU+ born	IPUMS	-
Spain	Other Europe	IPUMS	-
Spain	North Africa	IPUMS	-
Spain	Sub-Saharan Africa	IPUMS	-
Spain	West Asia	IPUMS	-
Spain	South & South-East Asia	IPUMS	-
Spain	East Asia	IPUMS	-
Spain	North America + Oceania	IPUMS	-
Spain	Latin America	IPUMS	-
Sweden	native-born	Eurostat	-
Sweden	EU+ born	DIOC + Eurostat	DIOC counts redistributed to 5year age groups and adjusted to match Eurostat counts by age and sex
Sweden	Other Europe	DIOC + Eurostat	DIOC counts redistributed to 5year age groups and adjusted to match Eurostat counts by age and sex
Sweden	North Africa	DIOC + Eurostat	DIOC counts redistributed to 5year age groups and adjusted to match Eurostat counts by age and sex
Sweden	Sub-Saharan Africa	DIOC + Eurostat	DIOC counts redistributed to 5year age groups and adjusted to match Eurostat counts by age and sex
Sweden	West Asia	DIOC + Eurostat	DIOC counts redistributed to 5year age groups and adjusted to match Eurostat counts by age and sex
Sweden	South & South-East Asia	DIOC + Eurostat	DIOC counts redistributed to 5year age groups and adjusted to match Eurostat counts by age and sex
Sweden	East Asia	DIOC + Eurostat	DIOC counts redistributed to 5year age groups and adjusted to match Eurostat counts by age and sex
Sweden	North America + Oceania	DIOC + Eurostat	DIOC counts redistributed to 5year age groups and adjusted to match Eurostat counts by age and sex
Sweden	Latin America	DIOC + Eurostat	DIOC counts redistributed to 5year age groups and adjusted to match Eurostat counts by age and sex
Switzerland	native-born	Eurostat	-
Switzerland	EU+ born	Eurostat	-
Switzerland	Other Europe	Eurostat	-
Switzerland	North Africa	Eurostat	counts for born in North Africa by age and sex, education attainment proportions from Africa
Switzerland	Sub-Saharan Africa	Eurostat	counts for born in Sub-Saharan Africa by age and sex, education attainment proportions from Africa
Switzerland	West Asia	Eurostat	counts for born in West Asia by age and sex, education attainment proportions from Asia
Switzerland	South & South-East Asia	Eurostat	counts for born in S&SE Asia by age and sex, education attainment proportions from Asia
Switzerland	East Asia	Eurostat	counts for born in East Asia by age and sex, education attainment proportions from Asia
Switzerland	North America + Oceania	Eurostat	-
Switzerland	Latin America	Eurostat	-

Country	Place of birth	Data sources	Adjustments
UK	native-born	Eurostat	-
UK	EU+ born	Eurostat	-
UK	Other Europe	Eurostat + DIOC	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
UK	North Africa	Eurostat + DIOC	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
UK	Sub-Saharan Africa	Eurostat + DIOC	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
UK	West Asia	Eurostat + DIOC	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
UK	South & South-East Asia	Eurostat + DIOC	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
UK	East Asia	Eurostat + DIOC	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
UK	North America + Oceania	Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex
UK	Latin America	Eurostat	DIOC counts redistribured to 5year age groups and adjusted to match Eurostat counts by age and sex

Appendix B

Baseline immigration flows by country of destination and region of birth (origin) for projection period 2020-24 until 2055-59

Destination	Place of birth	2020-24	2025-29	2030-34	2035-39	2040-44	2045-49	2050-54	2055-59
Austria	born outside EU+	287458	217303	223757	234687	238111	241592	221522	214443
Austria	East Asia	9853	8702	8420	8345	7973	7268	6479	5875
Austria	Latin America	8357	8343	8239	8138	8287	8146	7673	7383
Austria	North Africa	7018	7287	7957	8764	9232	9194	8916	8772
Austria	North America + Oceania	12845	10361	10059	9962	9933	9896	9805	9611
Austria	Other Europe	142226	71002	72260	76794	76598	70724	63088	58081
Austria	Sub-Saharan Africa	14189	16785	18405	20629	22488	23930	25125	26209
Austria	South & South-East Asia	40514	41463	42069	42144	41726	41024	40158	39086
Austria	West Asia	52456	53360	56349	59911	61873	71410	60278	59426
Belgium	born outside EU+	323225	283563	298380	317641	329949	339561	329333	328276
Belgium	East Asia	13159	11622	11245	11145	10649	9707	8653	7846
Belgium	Latin America	20196	20163	19911	19668	19963	19621	18545	17842
Belgium	North Africa	35963	37338	40771	44910	47307	47111	45687	44952
Belgium	North America + Oceania	23982	19307	18745	18564	18510	18441	18271	17909
Belgium	Other Europe	77639	29132	29648	31508	31428	29018	25885	23830
Belgium	Sub-Saharan Africa	70001	82032	91198	102220	111430	118573	124488	129865
Belgium	South & South-East Asia	42765	43767	44409	44488	44047	43306	42391	41260
Belgium	West Asia	39520	40202	42453	45137	46615	53783	45414	44772
Bulgaria	born outside EU+	114415	73433	75118	79443	79899	78622	69646	65695
Bulgaria	East Asia	1399	1236	1195	1185	1132	1032	920	834
Bulgaria	Latin America	490	489	483	477	479	471	450	433
Bulgaria	North Africa	751	779	851	937	987	983	953	938
Bulgaria	North America + Oceania	5154	4020	3903	3866	3854	3840	3805	3729
Bulgaria	Other Europe	90804	50645	51542	54776	54637	50447	45000	41429
Bulgaria	Sub-Saharan Africa	933	1113	1210	1356	1478	1573	1651	1722
Bulgaria	South & South-East Asia	1495	1531	1552	1555	1539	1513	1481	1442
Bulgaria	West Asia	13389	13619	14382	15291	15792	18763	15385	15168

Destination	Place of birth	2020-24	2025-29	2030-34	2035-39	2040-44	2045-49	2050-54	2055-59
Croatia	born outside EU+	63134	43594	46609	46723	46666	43724	39443	36701
Croatia	East Asia	1003	886	3207	850	812	740	660	598
Croatia	Latin America	628	627	619	611	610	599	576	554
Croatia	North Africa	149	155	169	186	196	195	189	186
Croatia	North America + Oceania	3390	2669	2591	2567	2559	2550	2526	2476
Croatia	Other Europe	55708	36876	37529	39884	39782	36732	32766	30165
Croatia	Sub-Saharan Africa	437	524	572	641	699	744	781	814
Croatia	South & South-East Asia	920	942	955	957	947	931	911	887
Croatia	West Asia	900	915	967	1028	1061	1234	1034	1019
Cyprus	born outside EU+	30343	20099	30349	22285	22969	23582	22558	22339
Cyprus	East Asia	516	456	9751	437	418	381	340	308
Cyprus	Latin America	704	703	694	685	695	683	646	622
Cyprus	North Africa	1139	1183	1292	1423	1499	1493	1448	1424
Cyprus	North America + Oceania	1640	1301	1263	1251	1247	1243	1231	1207
Cyprus	Other Europe	14594	3844	3912	4157	4147	3829	3415	3144
Cyprus	Sub-Saharan Africa	4166	4873	5445	6103	6653	7080	7433	7754
Cyprus	South & South-East Asia	4217	4315	4376	4383	4340	4267	4177	4066
Cyprus	West Asia	3366	3424	3616	3845	3971	4607	3868	3814
Czechia	born outside EU+	429190	102209	101353	109447	110839	108751	102332	98803
Czechia	East Asia	7549	6667	3446	6394	6109	5568	4964	4501
Czechia	Latin America	6095	6085	6009	5936	5977	5874	5597	5385
Czechia	North Africa	3886	4034	4405	4853	5112	5090	4936	4857
Czechia	North America + Oceania	9836	7745	7520	7447	7426	7398	7330	7185
Czechia	Other Europe	368445	41610	42346	45004	44889	41447	36972	34037
Czechia	Sub-Saharan Africa	10941	13144	14096	15800	17224	18328	19242	20073
Czechia	South & South-East Asia	15727	16095	16319	16348	16186	15914	15578	15162
Czechia	West Asia	6712	6828	7210	7666	7917	9132	7713	7604

Destination	Place of birth	2020-24	2025-29	2030-34	2035-39	2040-44	2045-49	2050-54	2055-59
Denmark	born outside EU+	163953	131646	185141	139553	141730	147366	136755	134388
Denmark	East Asia	9624	8501	58621	8151	7788	7099	6337	5746
Denmark	Latin America	7324	7312	7221	7133	7274	7150	6729	6474
Denmark	North Africa	2119	2200	2403	2647	2788	2776	2692	2652
Denmark	North America + Oceania	28699	22225	21579	21371	21309	21230	21034	20617
Denmark	Other Europe	43813	15364	15636	16617	16575	15303	13655	12571
Denmark	Sub-Saharan Africa	12940	15115	16750	18774	20465	21777	22864	23851
Denmark	South & South-East Asia	32490	33523	33990	34050	33713	33146	32446	31917
Denmark	West Asia	26942	27406	28941	30810	31819	38885	30999	30560
Estonia	born outside EU+	60513	15106	19262	16108	16174	15701	14241	13478
Estonia	East Asia	445	393	4298	377	360	329	293	266
Estonia	Latin America	404	403	398	393	401	394	371	357
Estonia	North Africa	161	167	182	201	212	211	205	201
Estonia	North America + Oceania	2130	1629	1581	1566	1562	1556	1541	1511
Estonia	Other Europe	54562	9575	9745	10356	10330	9538	8508	7833
Estonia	Sub-Saharan Africa	489	569	603	676	737	785	824	860
Estonia	South & South-East Asia	1112	1139	1154	1156	1145	1126	1109	1079
Estonia	West Asia	1209	1230	1299	1381	1427	1762	1390	1371
Finland	born outside EU+	121519	88576	114788	95374	97094	98277	93319	91460
Finland	East Asia	5954	5259	28619	5043	4818	4392	3915	3550
Finland	Latin America	2947	2943	2906	2870	2876	2827	2707	2604
Finland	North Africa	2199	2283	2493	2747	2893	2881	2794	2749
Finland	North America + Oceania	9223	7472	7255	7185	7164	7137	7071	6931
Finland	Other Europe	50449	16947	17247	18329	18282	16880	15058	13863
Finland	Sub-Saharan Africa	11261	13364	14696	16472	17956	19108	20061	20926
Finland	South & South-East Asia	23082	23623	23952	23995	23757	23358	22865	22254
Finland	West Asia	16403	16685	17620	18734	19347	21695	18848	18582

Destination	Place of birth	2020-24	2025-29	2030-34	2035-39	2040-44	2045-49	2050-54	2055-59
France	born outside EU+	1106810	1040073	1063443	1156553	1200985	1224260	1195685	1190552
France	East Asia	68898	60857	31988	58357	55758	50824	45308	41084
France	Latin America	120124	119931	118432	116983	119197	117163	110304	106124
France	North Africa	189492	196736	214827	236650	249269	248238	240736	236863
France	North America + Oceania	106055	82719	80311	79538	79305	79012	78282	76730
France	Other Europe	158353	69777	71012	75468	75276	69503	61999	57078
France	Sub-Saharan Africa	241432	282796	313617	351520	383281	407741	428195	446677
France	South & South-East Asia	156294	159956	162184	162473	160861	158157	154816	151026
France	West Asia	66161	67302	71071	75563	78038	93621	76044	74969
Germany	born outside EU+	3040201	2293516	2326015	2501918	2556504	2659435	2428535	2371343
Germany	East Asia	127621	112719	57777	108088	103275	94136	83920	76147
Germany	Latin America	122099	121902	120378	118906	120396	118330	112117	107898
Germany	North Africa	99970	103820	113367	124876	131540	130991	127032	124988
Germany	North America + Oceania	105356	84227	81775	80989	80751	80453	79709	78129
Germany	Other Europe	1303715	530823	540222	574120	572657	528741	471657	434249
Germany	Sub-Saharan Africa	220700	258709	286550	321402	350359	372820	391416	408311
Germany	South & South-East Asia	369945	378614	383888	384571	382720	376286	368338	358504
Germany	West Asia	690796	702702	742058	788965	814804	957679	794347	783117
Greece	born outside EU+	155356	138931	171052	152736	156726	157139	150727	148031
Greece	East Asia	6504	5745	32214	5509	5264	4798	4277	3878
Greece	Latin America	7323	7311	7221	7132	7185	7061	6725	6470
Greece	North Africa	12247	12716	13885	15294	16111	16045	15560	15310
Greece	North America + Oceania	13382	11371	11040	10934	10902	10862	10761	10548
Greece	Other Europe	54464	35523	36152	38420	38322	35383	31563	29058
Greece	Sub-Saharan Africa	22683	26722	29607	33186	36175	38495	40415	42173
Greece	South & South-East Asia	19742	20205	20511	20548	20344	20002	19579	19057
Greece	West Asia	19010	19339	20422	21713	22424	24494	21846	21537

Destination	Place of birth	2020-24	2025-29	2030-34	2035-39	2040-44	2045-49	2050-54	2055-59
Hungary	born outside EU+	88153	63222	62024	67593	68609	68636	64618	62830
Hungary	East Asia	7312	6458	3553	6193	5917	5394	4808	4360
Hungary	Latin America	4569	4562	4505	4450	4478	4400	4196	4037
Hungary	North Africa	4140	4298	4694	5170	5446	5423	5259	5175
Hungary	North America + Oceania	7289	5761	5593	5539	5523	5503	5452	5344
Hungary	Other Europe	39508	15150	15418	16386	16344	15090	13461	12393
Hungary	Sub-Saharan Africa	6480	7747	8396	9411	10258	10916	11461	11955
Hungary	South & South-East Asia	10624	10873	11025	11044	10935	10751	10524	10243
Hungary	West Asia	8231	8372	8841	9400	9708	11159	9458	9324
Ireland	born outside EU+	219973	150518	149020	152570	155408	157598	151674	149220
Ireland	East Asia	10112	8932	7447	8565	8183	7462	6652	6032
Ireland	Latin America	20845	20811	20551	20300	21535	21182	19148	18422
Ireland	North Africa	1859	1931	2108	2322	2446	2436	2362	2325
Ireland	North America + Oceania	93419	70598	68565	67925	67703	67432	66832	65503
Ireland	Other Europe	51618	3004	3057	3249	3241	2992	2669	2458
Ireland	Sub-Saharan Africa	14947	17489	18760	21021	22929	24383	25616	26712
Ireland	South & South-East Asia	18031	18454	18711	18744	18584	18272	17886	17409
Ireland	West Asia	9142	9300	9820	10444	10786	13439	10508	10360
Iceland	born outside EU+	9129	7060	7398	7349	7451	7527	7189	7043
Iceland	East Asia	370	327	555	314	300	273	244	221
Iceland	Latin America	584	583	576	569	590	580	536	516
Iceland	North Africa	135	141	153	169	178	177	172	169
Iceland	North America + Oceania	2680	2092	2031	2012	2006	1998	1980	1941
Iceland	Other Europe	2425	828	842	895	893	824	735	677
Iceland	Sub-Saharan Africa	649	753	844	946	1031	1097	1152	1202
Iceland	South & South-East Asia	1623	1661	1684	1687	1670	1642	1607	1565
Iceland	West Asia	664	675	713	758	783	934	763	752

Destination	Place of birth	2020-24	2025-29	2030-34	2035-39	2040-44	2045-49	2050-54	2055-59
Italy	born outside EU+	1456458	1368761	1389083	1498589	1541785	1539664	1508397	1490979
Italy	East Asia	84480	74623	40420	71558	68371	62321	55557	50377
Italy	Latin America	204441	204111	201560	199095	199121	195661	187728	180613
Italy	North Africa	197351	204895	223732	246474	259605	258518	250729	246695
Italy	North America + Oceania	33260	29083	28237	27965	27883	27780	27523	26978
Italy	Other Europe	341705	201036	204596	217434	216880	200248	178629	164451
Italy	Sub-Saharan Africa	269942	322339	351661	394162	429626	457178	480210	500938
Italy	South & South-East Asia	288593	295356	299470	300003	297027	292034	285865	279352
Italy	West Asia	36685	37317	39407	41898	43270	45925	42155	41575
Latvia	born outside EU+	56072	29553	29851	31854	32047	31327	28028	26481
Latvia	East Asia	1268	1120	781	1074	1026	935	834	756
Latvia	Latin America	768	766	757	748	755	742	705	678
Latvia	North Africa	268	279	304	335	353	352	341	335
Latvia	North America + Oceania	1631	1263	1227	1215	1211	1207	1196	1172
Latvia	Other Europe	46193	19886	20238	21508	21454	19808	17670	16267
Latvia	Sub-Saharan Africa	1064	1268	1336	1497	1632	1737	1824	1902
Latvia	South & South-East Asia	937	959	972	974	964	948	928	903
Latvia	West Asia	3943	4011	4236	4504	4651	5598	4531	4467
Lithuania	born outside EU+	85739	32833	33233	35015	35107	34176	30623	28868
Lithuania	East Asia	561	495	398	475	454	414	369	335
Lithuania	Latin America	481	480	474	469	475	467	442	425
Lithuania	North Africa	276	286	313	344	363	361	350	345
Lithuania	North America + Oceania	4941	3662	3555	3521	3511	3498	3465	3397
Lithuania	Other Europe	74067	22281	22675	24098	24037	22193	19797	18226
Lithuania	Sub-Saharan Africa	546	663	654	733	799	850	892	931
Lithuania	South & South-East Asia	1819	1864	1889	1893	1874	1843	1804	1756
Lithuania	West Asia	3048	3101	3275	3482	3596	4551	3503	3454

Destination	Place of birth	2020-24	2025-29	2030-34	2035-39	2040-44	2045-49	2050-54	2055-59
Luxembourg	born outside EU+	11418	6642	42776	7215	7426	7479	7248	7159
Luxembourg	East Asia	428	378	36277	362	346	315	282	255
Luxembourg	Latin America	846	845	834	824	840	826	777	748
Luxembourg	North Africa	395	410	448	493	519	517	502	494
Luxembourg	North America + Oceania	1402	1055	1025	1015	1012	1008	999	979
Luxembourg	Other Europe	5970	1321	1344	1428	1425	1315	1174	1080
Luxembourg	Sub-Saharan Africa	1438	1674	1860	2085	2273	2418	2539	2649
Luxembourg	South & South-East Asia	674	689	703	704	697	686	671	653
Luxembourg	West Asia	265	270	285	303	313	393	305	301
Malta	born outside EU+	8354	7210	7637	8059	8409	8660	8566	8598
Malta	East Asia	258	228	293	219	209	191	170	154
Malta	Latin America	354	353	349	344	352	347	325	313
Malta	North Africa	920	955	1043	1149	1210	1205	1170	1151
Malta	North America + Oceania	1799	1392	1352	1339	1335	1330	1317	1291
Malta	Other Europe	1638	507	516	548	547	505	451	415
Malta	Sub-Saharan Africa	2196	2560	2834	3177	3463	3685	3876	4043
Malta	South & South-East Asia	735	752	763	764	756	744	735	716
Malta	West Asia	454	462	488	519	536	654	522	515
Netherlands	born outside EU+	433826	370088	367187	397083	405912	414716	394526	388241
Netherlands	East Asia	33620	29694	14908	28474	27206	24799	22108	20046
Netherlands	Latin America	46706	46631	46048	45485	45924	45134	42888	41263
Netherlands	North Africa	19504	20250	22112	24357	25657	25550	24777	24379
Netherlands	North America + Oceania	54479	43850	42573	42163	42040	41885	41497	40675
Netherlands	Other Europe	99003	37385	38047	40434	40331	37238	33218	30582
Netherlands	Sub-Saharan Africa	52094	61207	67861	76062	82915	88236	92637	96636
Netherlands	South & South-East Asia	64369	65916	66834	66953	66289	65175	63798	62095
Netherlands	West Asia	64051	65155	68804	73153	75549	86700	73602	72566

Destination	Place of birth	2020-24	2025-29	2030-34	2035-39	2040-44	2045-49	2050-54	2055-59
Norway	born outside EU+	180030	156722	289723	172503	177968	184852	178084	177469
Norway	East Asia	5827	5146	131042	4935	4715	4298	3832	3474
Norway	Latin America	7381	7369	7277	7188	7250	7125	6778	6521
Norway	North Africa	3126	3245	3544	3903	4112	4094	3971	3907
Norway	North America + Oceania	15216	12081	11730	11617	11583	11540	11433	11207
Norway	Other Europe	41756	14243	14495	15405	15366	14187	12656	11651
Norway	Sub-Saharan Africa	37147	43600	48429	54282	59173	62967	66109	68963
Norway	South & South-East Asia	42021	43006	43605	43700	43267	42539	41641	40529
Norway	West Asia	27556	28031	29601	31472	32503	38101	31665	31218
Poland	born outside EU+	1290166	237527	238564	256515	259825	259352	237220	228101
Poland	East Asia	11898	10509	5194	10077	9628	8776	7824	7094
Poland	Latin America	12264	12245	12092	11944	11975	11768	11262	10835
Poland	North Africa	7838	8138	8886	9788	10311	10268	9957	9797
Poland	North America + Oceania	28639	20845	20238	20043	19984	19910	19726	19335
Poland	Other Europe	1163523	115123	117162	124514	124196	114672	102292	94173
Poland	Sub-Saharan Africa	21205	24985	27540	30869	33650	35807	37593	39216
Poland	South & South-East Asia	18360	18790	19052	19086	18897	18579	18187	17701
Poland	West Asia	26438	26893	28400	30195	31184	39572	30380	29951
Portugal	born outside EU+	277289	244933	262047	258871	267202	269349	265311	263203
Portugal	East Asia	7157	6322	17422	6062	5792	5279	4706	4268
Portugal	Latin America	132604	132390	130735	129136	130329	128085	121763	117148
Portugal	North Africa	2822	2930	3199	3524	3712	3697	3585	3527
Portugal	North America + Oceania	13469	10853	10537	10436	10405	10367	10271	10067
Portugal	Other Europe	48320	9292	9456	10049	10024	9255	8256	7601
Portugal	Sub-Saharan Africa	55820	65662	72886	81695	89055	94765	99491	103786
Portugal	South & South-East Asia	15185	15541	15758	15787	15630	15367	15043	14641
Portugal	West Asia	1911	1944	2053	2182	2254	2534	2196	2165

Destination	Place of birth	2020-24	2025-29	2030-34	2035-39	2040-44	2045-49	2050-54	2055-59
Romania	born outside EU+	191011	111868	113611	120410	122505	125079	114184	110652
Romania	East Asia	8516	7522	6128	7213	6891	6282	5600	5078
Romania	Latin America	10083	10067	9941	9820	9967	9797	9259	8908
Romania	North Africa	6580	6831	7460	8217	8655	8619	8359	8224
Romania	North America + Oceania	15945	12095	11742	11629	11595	11552	11446	11219
Romania	Other Europe	112077	35283	35908	38161	38063	35144	31350	28862
Romania	Sub-Saharan Africa	9494	11223	12272	13755	14995	15956	16752	17475
Romania	South & South-East Asia	7063	7229	7329	7342	7270	7147	6996	6810
Romania	West Asia	21253	21619	22830	24273	25068	30582	24422	24077
Slovakia	born outside EU+	87368	14771	18134	15386	15450	15248	14148	13571
Slovakia	East Asia	928	820	4035	786	751	685	610	554
Slovakia	Latin America	643	642	634	627	634	623	591	568
Slovakia	North Africa	450	468	511	562	592	590	572	563
Slovakia	North America + Oceania	5409	4304	4178	4138	4126	4111	4073	3992
Slovakia	Other Europe	76813	5299	5393	5731	5717	5278	4708	4335
Slovakia	Sub-Saharan Africa	321	380	415	465	507	540	567	591
Slovakia	South & South-East Asia	1230	1259	1278	1280	1267	1246	1220	1187
Slovakia	West Asia	1572	1599	1689	1796	1855	2175	1807	1781
Slovenia	born outside EU+	75815	61479	65239	66201	66111	61525	55363	51325
Slovenia	East Asia	796	703	3398	674	644	587	523	474
Slovenia	Latin America	804	803	793	783	781	767	739	711
Slovenia	North Africa	236	245	268	295	310	309	300	295
Slovenia	North America + Oceania	2182	1804	1752	1735	1730	1723	1708	1674
Slovenia	Other Europe	69610	55615	56599	60151	59998	55397	49416	45494
Slovenia	Sub-Saharan Africa	473	560	620	695	757	806	846	883
Slovenia	South & South-East Asia	872	892	905	906	897	882	864	841
Slovenia	West Asia	842	857	905	962	994	1053	968	954

Destination	Place of birth	2020-24	2025-29	2030-34	2035-39	2040-44	2045-49	2050-54	2055-59
Spain	born outside EU+	1831101	1725474	1728357	1796686	1838519	1823719	1754031	1710691
Spain	East Asia	61064	53934	26293	51718	49446	45070	40179	36433
Spain	Latin America	998533	996923	984508	972809	984515	967563	917229	882462
Spain	North Africa	250073	259632	283394	312289	328854	327789	317568	312458
Spain	North America + Oceania	76244	62666	60842	60257	60080	59858	59305	58130
Spain	Other Europe	194334	76988	78355	83272	83060	76690	68410	62981
Spain	Sub-Saharan Africa	125802	147460	163891	183698	200249	212888	223715	233718
Spain	South & South-East Asia	104809	107265	109315	109510	108423	106601	104349	101563
Spain	West Asia	20243	20605	21759	23134	23892	27260	23276	22947
Sweden	born outside EU+	492233	461232	479803	512759	535911	586801	549388	555112
Sweden	East Asia	21921	19361	14478	18566	17739	16220	14460	13111
Sweden	Latin America	15181	15156	14967	14784	15048	14816	13964	13435
Sweden	North Africa	14588	15146	16539	18218	19190	19110	18965	19399
Sweden	North America + Oceania	33061	26210	25447	25202	25138	25046	24814	24322
Sweden	Other Europe	80806	41083	41810	44434	44320	40921	36531	33632
Sweden	Sub-Saharan Africa	81697	94550	105955	118760	129460	137760	144631	160016
Sweden	South & South-East Asia	84545	86527	87732	88992	95191	95299	96103	93537
Sweden	West Asia	160434	163199	172876	183804	189823	237630	199920	197659
Switzerland	born outside EU+	296444	229981	224310	240963	244613	243829	231302	225096
Switzerland	East Asia	22309	19706	9875	18897	18055	16457	14671	13303
Switzerland	Latin America	35211	35155	34715	34291	35293	34697	32333	31107
Switzerland	North Africa	9894	10273	11218	12357	13017	12962	12571	12368
Switzerland	North America + Oceania	52481	41620	40408	40019	39902	39755	39387	38606
Switzerland	Other Europe	101022	42798	43556	46289	46171	42630	38028	35010
Switzerland	Sub-Saharan Africa	21580	25322	27954	31333	34163	36354	38167	39814
Switzerland	South & South-East Asia	37379	38255	38788	38857	38472	37825	37105	36114
Switzerland	West Asia	16566	16852	17796	18921	19540	23150	19041	18772

Destination	Place of birth	2020-24	2025-29	2030-34	2035-39	2040-44	2045-49	2050-54	2055-59
UK	born outside EU+	2285724	2122373	2024280	2208869	2247826	2264396	2204940	2175639
UK	East Asia	300808	265629	137843	254718	243434	221817	197755	179316
UK	Latin America	82976	82863	81862	80828	87059	85654	76216	73330
UK	North Africa	54111	56157	61347	67547	71150	70853	68717	67609
UK	North America + Oceania	533123	429074	416597	412659	411442	409826	406157	398077
UK	Other Europe	174953	61273	62357	66271	66103	61035	54446	50126
UK	Sub-Saharan Africa	346661	416287	436517	489166	533246	567456	595622	621375
UK	South & South-East Asia	667470	683332	692839	694229	687190	675479	661718	643524
UK	West Asia	125623	127757	134918	143450	148202	172276	144308	142282
EU+	**TOTAL**	**15272419**	**11850294**	**12187544**	**12726958**	**13035730**	**13241945**	**12608937**	**12395784**