The Impact of Migration on Future Population Change

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with integrated immigration and emigration assumptions
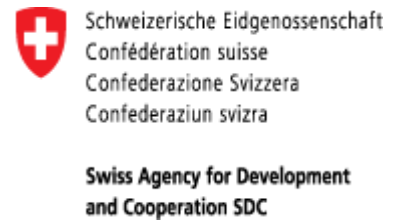
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The Impact of Migration on Future Population Change – Global demographic projections with integrated immigration and emigration assumptions*

Thomas Buettner and Rainer Muenz †

Abstract

In a growing number of countries international migration has a significant impact on the population size and structure this is both true for sending and receiving countries. Despite this fact most population projections apply the residual concept of net migration in their underlying models and rely on fairly simple assumptions about future migration flows.

This paper proposes an alternative approach by modelling immigration and emigration separately. This approach is integrated in a global population projection that covers bilateral migration flows between (almost) all countries of the world. These assumptions are based on flow estimated derived from a conversion of available UN DESA time series on stocks of international migrants into bilateral migration flows.

The paper develops the integrated population forecasting model. It presents and discusses the results for a selected number of countries as well as for the EU as a whole. And it compares the results of this alternative projection with those of the standard UN Population Prospect forecast (main variant with migration and contrasting variant without migration).

For a more detailed account of data, methods and results details see also the technical paper: Th. Buettner, R. Muenz. 2024. The Impact of Migration on Future Population Change. Technical Information. KNOMAD Working Paper no. 60, published in parallel to this paper.

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1   Introduction: Gross or Net Migration

The number of international migrants has doubled since the 1990s and continues to grow. This has an impact on the population size and structure of both sending and receiving countries. We can assume that this will also be the case in the decades to come: The majority of high-income countries with ageing societies and low fertility will be recruiting migrant labour. At the same time, young adults in middle- and low-income countries will continue to seek employment opportunities outside their country of origin. And family reunion as well as marriage migration will continue to be relevant legal avenues for international migrants. This has ample implications for demographic forecasting. Population projections both for sending and receiving countries need to put more emphasis on the modeling of future migration flows. This paper tries to demonstrate that population projections should incorporate assumptions on future immigration and emigration.

The question, however, is: On which empirical data should we build our assumptions? Only more developed countries document international migration flows across their borders. For these countries we able are to analyse international migration as documented flow of people. Globally there are about 50 countries which collect and publish usable migration statistics (Buettner 2022). Even For these countries we able are to analyse international migration as a statistically identified flow of people. But even for countries with a developed statistical system, immigrants are usually much better documented and accounted for than emigrants. In the absence of complete flow data, demographers apply the concept of net migration (immigration minus emigration) as this can be calculated as a residual derived from more reliable population stock data.

Comparison among countries collecting data on immigration (and to a lesser extent on emigration) can be a challenge as receiving countries apply different concepts and practices in registering newly arriving migrants and defining the foreign (born) population living on their territory. At the same time, sending countries often do not deregister emigrants assuming that their departure would be temporary. In a considerable number of cases emigrants are avoiding deregistration because they have a personal interest in maintaining a residence in their country of origin.

Less developed countries are often lacking resources and stable institutions to account for international migration at all. In that case the starting point of the analysis is the stock of migrants. If this information is available it allows for an (indirect) estimation of migration flows by looking at changes in the migrant stock derived from decennial censuses, intermediate micro-censuses or population registers. For other countries the analysis has to rely on estimates; or emigration flows from particular sending countries are reconstructed through information on origins of immigrants collected by receiving countries.

Almost all national as well as international population projections calculate future births and deaths by making separate assumptions about future trends in fertility and mortality. But they use fairly crude net migration assumptions as a proxy of the future migration component. Demographic projections that include separate assumptions for immigration and emigration are rare.[1]

This paper tries to demonstrate the merits of a global population projection that incorporates assumptions about bilateral migration flows between (almost) all countries of the world. These assumptions are based on flow estimated derived from the groundbreaking calculations of Abel (2022)

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[1] For attempts to incorporate bilateral migration flow estimates see: Rikani and Schewe (2021); Buettner (2023). Lutz et al. (2014) implemented a simplified migration flow model.

and <u>Abel and Cohen (2022)</u>.[2] Their work presents global emigration/immigration flow data by gender which are derived from the global migrant stock data published by the UN Population division. The projections presented in this paper integrates them into a population forecasting model. The results are presented and discussed for a selected number of countries and compared to the standard UN Population Prospect forecast (main variant with migration and contrasting variant without migration).

1.1 Advances and Shortcomings in Migration Statistics

As discussed, there is an obvious shortcoming in official statistics: The incomplete coverage of international migration. Other (countable) issues, such as trade of goods, financial flows, numbers of tourists, etc. are well recorded, verified, standardized and published by national statistical offices (NSO) and international agencies. Human mobility across international borders, on the other hand, is available for less than 50 countries (<u>Buettner 2022</u>). And even the statistics produced by the few countries that record immigration and emigration are often not complete and not compatible with migration figures given by other countries.

The dominant concept in population projections regarding the migration component is still net migration. Net migration, an entity that does not exist in reality and that cannot be observed, is derived from the fundamental balance equation of demographic change. Despite its conceptual weakness, there is a very simple way of estimation the migratory component of population change between two points in time. Given the population at time A and B, and the known number of births and deaths during the period AB, net international mobility is the increase or decrease in population size not explained by births and deaths (error of closure). This metric is widely used in national population tabulations and population projections relying on (usually rather crude) assumptions about future net migration. The concept of net migration effectively hides the connectedness of countries. The statistic is also beset with other problems. Because it is derived from four demographic variables - Population at the beginning and at the end of a well-defined period and the number of births and deaths - it collects inadvertently their measurement errors. As result (see below), net migration for some countries exhibits wild fluctuation.

1.2 A big step forward: estimating immigration and emigration flows.

Improvements during the last decades have opened the way to deal with migration flows by attacking the problem indirectly. Guy <u>Abel (2022)</u> pioneered the estimation of international migration flows by using specific information from census and micro-census data. The data set distinguishes people in migrant receiving countries by distinguishing the status of its population according to citizenship or country of birth. In the absence of data on country of birth it is assumed that those with foreign citizenship or were born in another country must have moved to the country conducting the census. Since the date of entering the country of destination is not easily obtainable, the change in stock between two censuses is then taken as the amount of mobility and the period between the two censuses as the estimated time of movement. As with the application of the concept of net migration, flow estimates are also carrying measurement errors and inconsistencies in definitions of citizenship. The estimates published by <u>Abel (2022)</u> and <u>Abel and Cohen (2022)</u> allow for the reconstruction of past bilateral migration flows between individual countries. As censuses (usually) contain information on gender the estimates are available for migrating men and migrating woman.

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[2] A similar approach has been suggested and applied by <u>Azose and Raftery (2018).</u> For an appraisal and visualization of Abel's results see <u>Koeppen et al. (2023).</u> This stock-to-flow transformation also shows inconsistency and limits of the underlying data published by the UN Population Division (discussed in <u>Koeppen et al. (2023).</u>

2 Projections of bilateral migration flows

The venture into integrating international migration flows started with an evaluation and corresponding revision of the raw migration estimates provided by Abel and Cohen (2022). As a result, we could include 194 countries (see Annex for more details) into the final projection of migration flows and, subsequently, populations in an integrated manner. It is important to acknowledge that the chosen demographic format was by single years,[3] thereby following the UN's lead.

The projection of migration movements globally is the next step for an integrated population projection incorporating bilateral migration flows. In order to fit into the UN's numeric framework, the raw estimates were interpolated into single calendar years, both for total males and total females between 1990 and 2019. The time series of annualized total migration figures for both gender combined were then used for forecasting from 2020 to 2049. To ensure better numerical stability, we applied the average past gender ratio of bilateral migration flows to split the projected migration for both gender into male and female migrants. After the final total migrants by gender have been calculated, in a further step they were split into single years of age by applying the simplified Model Migration Schedule introduced by Rogers and Castro (Castro and Rogers 1979; Rogers and Castro 1981; Castro 1981).[4]

The projections of total bilateral migration flows were executed first, followed by imposing an age structure on the total emigrants/immigrants. in a further step, the migrants by age (101 age groups) and gender (male, female) transformed into matrices of age-specific migration rates. As final step, a multistate population projection was carried out, combining the base population by gender with age-specific fertility rates, age specific mortality rates and the just mentioned bilateral matrices with age specific migration rates.[5]

2.1 Migration Flow Estimates and Projections by Origin and Destination

The projection of total bilateral migration flows – prepared as indicated above – results in a comprehensive and voluminous dataset. For this paper, we limit the results to selected summary indicators, such as total emigration/immigration and the tabulation of some regional aggregates.

2.1.1 Global mobility

In a global context, emigration always equals immigration, even if available data might suggest otherwise. So, to get a sense about the magnitude of global human international mobility, the sum of all emigrants at any year should equal the total number of immigrants at the same year. We show below the magnitude of international migration by aggregating the emigration flows taken from the bilateral migration matrix by origin and destination for each calendar year (see figure) and by the sums over 5-year periods (see Table). These figures complement the usually cited figure of about 281 million people living outside their country of birth (mid-year migrant stock, published by the UN Population Division.[6] Both statistics present valuable information about the migration and thus are useful, inter alia, for policy formulations.

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[3] The residual method to calculate net migration is: total population change during a defined period (usually a calendar year) plus births minus deaths.

[4] See also Raymer and Abel (2008). For a practical introduction and pitfalls to avoid, see Buettner and Muenz (2018b, 2018a).

[5] For more details see the technical paper Th. Buettner, R. Muenz. 2024. The Impact of Migration on Future Population Change. Technical Information. KNOMAD Working Paper no. 60, published in parallel to this paper.

[6] https://www.un.org/en/global-issues/migration; see also IOM (2021).

1. The migrant stock data refer to snapshots of how many people have moved from one country to another country during their lifetime and were still present at the time of recording or estimation. This is an aggregation of past flows minus migrants who returned to their country of origin or died outside their country of birth.

2. The migrant flow data, on the other hand, show the amount of people who have actually changed their residence across an international border during a particular year, or during a particular five-year period (as shown in table 1).

Figure 1: Global estimates (1990-2019) and projections (2020-2049) of emigrants/immigrants
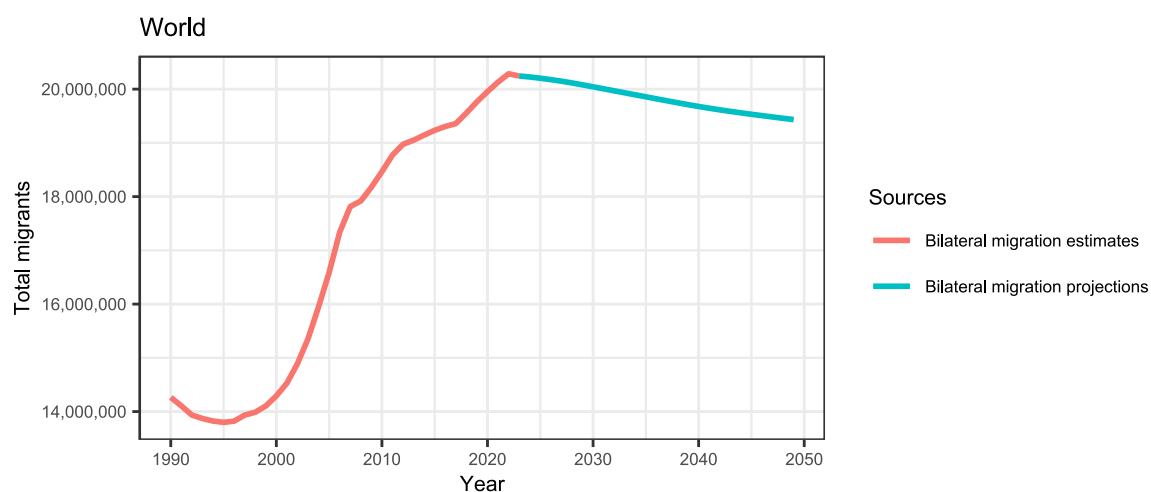
The overall annual number of international migrants has increased from about 14 million in 1990 to about 20 million in 2019 (+39%). Somewhat counter intuitively, the aggregated number of international migrants is forecasted to decline slightly to about 19.4 million annually. See Table 1 and Figure 1 presenting the estimated (1990-2019) and forecasted (2020-2049) total volumes of migration flow for a period of five calendar years.

Table 1: World: Total Flow of Emigrants/Immigrants, 5 Year-Periods Combined

Years	Bilateral migration estimates	Bilateral migration projections
1990-1994	69,999,707	
1995-1999	69,647,705	
2000-2004	75,014,031	
2005-2009	87,832,873	
2010-2014	94,406,500	
2015-2019	97,215,794	
2020-2024		100,840,637
2025-2029		100,721,396
2030-2034		99,843,379
2035-2039		98,916,721
2040-2044		98,080,377
2045-2049		97,410,384

Our paper shows the implication of the forecast for 20 selected sending and receiving countries that share certain migration related properties. In addition, results are shown for the European Union as one block (EU27).

2.1.2 Further Tabulations

We were trying to round the picture of international bilateral migration estimates and projections by preparing other tabulation, including origin-destination tables. Not to compromise readability too much, we decided to place some of these tabulation into the Annex. It was decided to focus on the well-established geographic regions defined by the World Bank. The migration matrices in Annex are formatted with origin groups as columns, and rows as destinations. Because of three dimension of the data - origin, destination and time - the bilateral migration matrices were printed separately, one flow matrix for each time period of five years, from 2020 to 2049. For the many possible ways to analyse of the flow matrices, see Buettner (2023).[7]

3 Population Projections

3.1 Data

Our population projections use the official 2022 Revision of UN's World Population Prospects (WPP) as its basis United Nations Population Division (2022). All population figures in our dataset between 1990 and 2022 are by single years of age and gender from the medium variant. Our own projections start with the base population as of 1. January 2023[8] and use the UN's medium fertility and mortality assumptions but replace the UN's net migration assumptions with our own projection of bilateral migration flows based on past bilateral migration flows. All demographic data are in an annual data format (single age groups and single calendar years) and distinguish between males and females.

As the underlying migration flow estimates are limited to 194 countries, our projection also provides projections for 194 countries only. The coverage regarding global population figures, however, is only marginally affected (see Annex).

It is important to recognize substantial changes in the estimation strategy of the last World Population Prospects (WPP). In order to guarantee internal consistency, the demographic figures of the past, that is the period from 1950 to 2022 are itself projections, starting in 1950. In other words, what is named past estimates is a demographic reconstruction of past trends, not a series of individual demographic indicators. Another change was moving the base date from mid-year to the beginning of each year. Finally, past WPP projections assumed, that international migration would come to an end (at least on a net basis). Until the early 2010s the end of international migration was set to materialize in 2100. Later this end of international migration was moved to 2150. As a result, projected net migration flows became smaller over the projected period. This was based on an underlying global convergence hypothesis assuming the emergence of similar living conditions in all (or at least most) parts of the world[9] which would make international migration "unnecessary". Since 2022 the UN Population Division has dropped this convergence hypothesis when modelling migration. In the WPP projection future annual net migration no longer declines over time.

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[7] The paper was built upon the work published for KNOMAD in 2023, see Koeppen et al. (2023) [@KoeppenKNOMAD].

[8] The UN's projection starts on 1. January 2022, its projection base year. We chose to move the base year of our projection one year forward in order to reflect the extraordinary migration of Ukrainian refugees, mostly into neighbouring countries as well as other EU+EFTA countries. By borrowing the population projections for the year 2022 from the UN's medium variant our projection was able to reflect this unique flow of more than 5 million Ukrainians in a single year.

[9] UN WPP projections were based on similar assumptions of converging fertility and mortality pattern.

3.2   Population Projections by Variants

3.2.1   Established immigration countries

Classical immigration countries are nations founded by colonial settlers. They look back on a long history of immigration. Some of them still attract considerable numbers of migrants coming from other parts of the world (Australia, Canada, New Zealand, USA). For others this is no longer the case (e.g., Argentia, Brazil).

3.2.1.1   United States of America

The USA is the country with the largest number of immigrants. Its population growth is driven both by a birth surplus and a considerable net gain from migration as there are many more people moving to the US than leaving the country. Since 1990 the US population grew by 94 million people. Without further migration the US population would stop growing in the second half of the 2030s. with a peak of 344 million inhabitants. It would then gradually decline to 338 million in 2050. With migration the US population will continue to grow until (and beyond) the year 2050 despite an excess of deaths over birth expected to start in the early 2040s. Our assumption based on a continuation of past immigration as well as emigration trends projects the US population to reach 379 million in 2050 (+41 million compared to 2022). The UN medium variant projects 375 million in 2050. Both results are similar as our projected difference between immigration and emigration does not differ a lot from the UN net migration assumption not looking at immigration and emigration separately. The US Census Bureau and the Congressional Budget Office assume considerable net gains from migration to continue and project that the US population will grow to 370 million in 2050.[10]

Figure 2: United States of America: Total population by variants, 1990-2050

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[10] https://www.cbo.gov/publication/58612
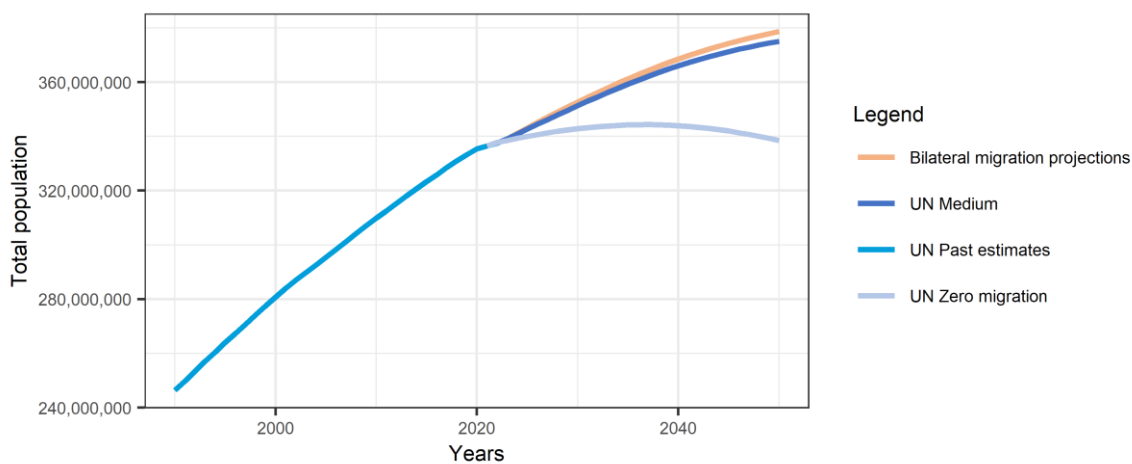
Table 2: United States of America: Total population by variants, 2020-2050

Time	Bilateral migration projections	UN Medium	UN Past estimates	UN Zero migration
2020			335,388,238	
2025	343,149,821	342,715,948		339,999,912
2030	352,683,647	351,334,473		342,849,425
2035	361,235,400	359,284,014		344,248,998
2040	368,516,009	366,038,726		343,983,916
2045	374,285,776	371,283,932		341,989,625
2050	378,680,188	375,084,703		338,456,805

Figure 3: United States of America: Total net migration by variants, 1990-2049
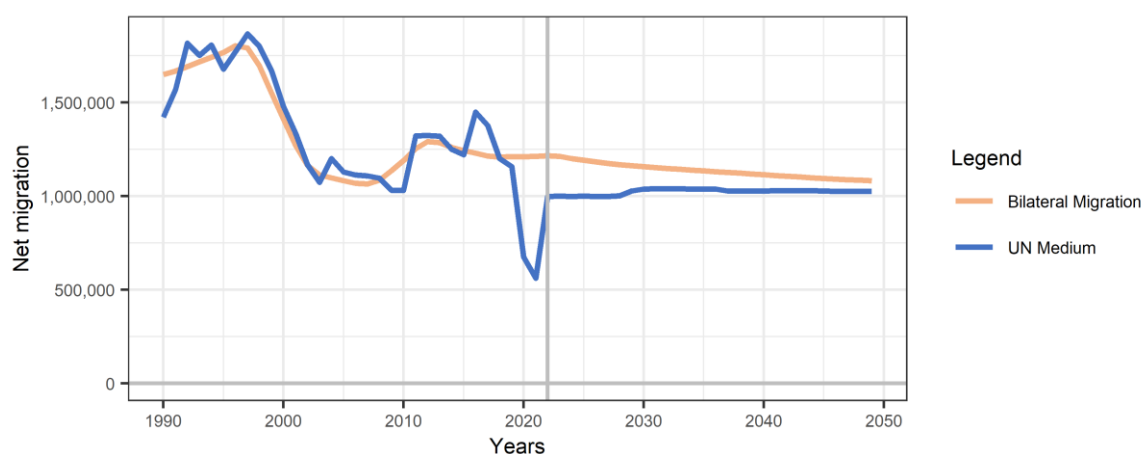
3.2.1.2 Canada

Fueled by a proactive and selective migration policy Canada's population grew by 11 million since 1990. In demographic terms immigration to Canada plays a larger role than in the USA. Without immigration Canada's population growth would come to a halt in the early 2030 (population peak at 38.7 million; +0.4 million compared to 2022). During the following two decades it would shrink to 36.8 million (-1.9 million compared to 2031).

When assuming continued migration Canada's population is projected to grow throughout the analysed period. According to our bilateral projection based on past immigration as well as emigration dynamics Canada's total population is projected to reach 50.3 million in 2050 (+2 million compared to 2022). The UN (in its main variant) only projects 45.8 million. The difference results from the fact that our calculated difference between immigration and emigration shows a bigger net gain than the one assumed in the UN projection.

Statistics Canada also assumes considerable net gains from migration and project that the total population will grow to 48.8 million in 2050.[11]

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[11] https://www150.statcan.gc.ca/n1/pub/91-520-x/91-520-x2022001-eng.htm

Figure 4: Canada: Total population by variants, 1990-2050

Table 3: Canada: Total population by variants, 2020-2050

Time	Bilateral migration projections	UN Medium	UN Past estimates	UN Zero migration
2020			37,758,232	
2025	39,585,431	39,269,317		38,535,995
2030	42,003,776	40,852,177		38,713,414
2035	44,315,934	42,362,943		38,610,974
2040	46,460,421	43,699,839		38,219,850
2045	48,431,871	44,829,762		37,591,123
2050	50,262,928	45,800,702		36,785,876

Figure 5: Canada: Total net migration by variants, 1990-2049
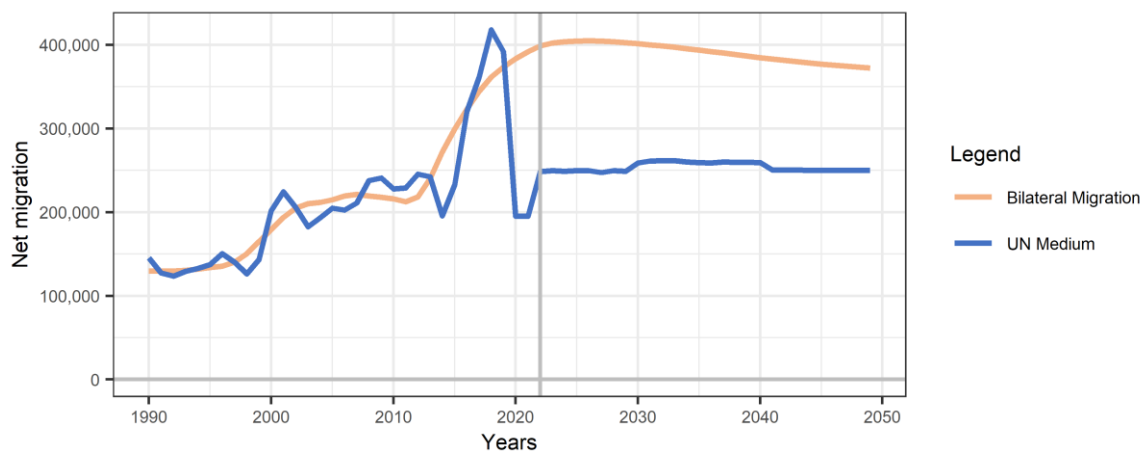
3.2.1.3 Australia

In Australia the gain from migration also has an important impact on total population growth. Driven by high annual numbers of new immigrants, Australia's total population grew by 9 million people between 1990 and 2022. Without migration Australia's population would peak at the beginning of the 2040s at 27.2 million (+1.3 million compared to 2022).

Our projection assumes a continuation of recent immigration and emigration dynamics. It puts Australia's population at 34.7 million in 2050 (+8.8 million compared to 2022). The UN (main variant) projects 32.1 million for the same year. Like in the case of Canada our calculated difference between immigration and emigration shows a bigger net gain than the one assumed in the UN projection. Australia's Bureau of Statistics also assumes continuing net gains from migration and projects the number of people living in the country to reach 34.9 million in 2050 (medium variant).[12]

Figure 6: Australia: Total population by variants, 1990-2050

Table 4: Australia: Total population by variants, 2020-2050

Time	Bilateral migration projections	UN Medium	UN Past estimates	UN Zero migration
2020			25,544,179	
2025	27,022,959	26,829,312		26,453,912
2030	28,763,451	28,083,558		26,906,456
2035	30,385,204	29,222,396		27,156,531
2040	31,894,750	30,257,271		27,240,561
2045	33,321,955	31,218,449		27,216,708
2050	34,673,572	32,109,135		27,099,321

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[12] https://www.abs.gov.au/statistics/people/population/population-projections-australia/2022-base-2071

Figure 7: Australia: Total net migration by variants, 1990-2049

3.2.2 New immigration countries

Some countries do not have a long tradition of immigration but have become "magnet societies" in the last decades of the 20th century. Unlike classical immigration countries many "new immigration countries" do not seek permanent immigrants but migrant labour at a rotational basis with strict enforcement of returns. This is particularly true for the Gulf States. In projections for such countries, separate assumptions for future immigration and emigration are of particular relevance.

3.2.2.1 United Arab Emirates

The United Arab Emirates are a good example of a new immigration country. It's population almost tripled between 1990 and 2010 and continued to increase at smaller pace until the present. This rapid population growth of the past decades was almost uniquely caused by migration. A large majority of people living in the UAE are temporary labour migrants – predominantly male migrants.

Without further immigration or emigration UAE's population growth would be minimal (from 9.4 million in 2022 to 10.2 million in 2050; +0.8 million). This would, however, require a deviation from the rotational model. As a result, the UN zero migration variant actually is a zero net migration variant which would go along with considerable immigration as well as emigration flows of the same magnitude. Our projection puts the UAE population of 2050 at 14.1 million (+4.7 million compared to 2022). The UN (main variant) projects 11.4 million. The reason for this divergence is the following: our calculated difference between immigration and emigration is based on the dynamics since 1990 leading to a bigger net gain than the one assumed in the UN projection which extrapolates the net migration gains between 2010 and 2020 only. The UAR does not provide national population projections for the Emirates.

Figure 8: United Arab Emirates: Total population by variants, 1990-2050


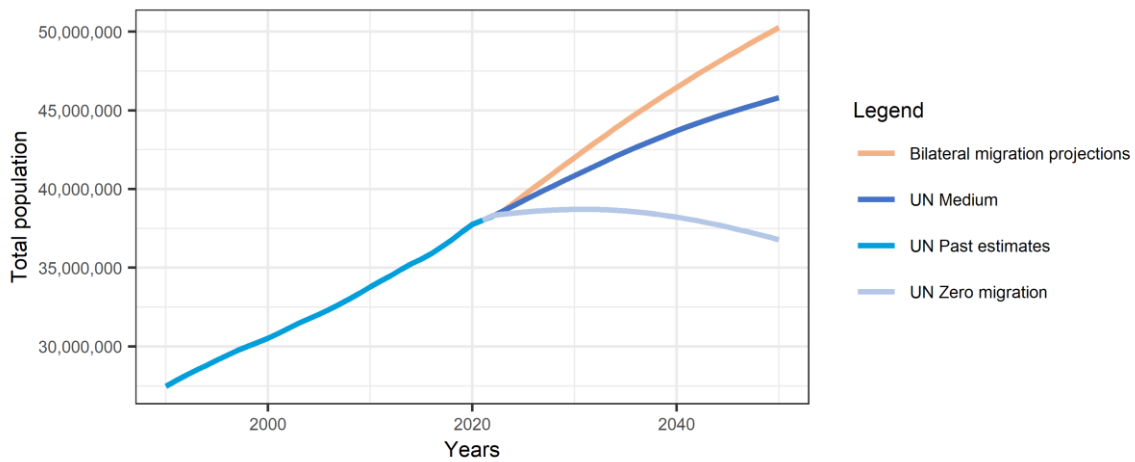**Table 5: United Arab Emirates: Total population by variants, 2020-2050**

Time	Bilateral migration projections	UN Medium	UN Past estimates	UN Zero migration
2020			9,247,550	
2025	9,857,198	9,628,961		9,655,340
2030	10,819,737	9,972,573		9,915,484
2035	11,733,765	10,287,103		10,059,791
2040	12,601,285	10,626,664		10,150,670
2045	13,412,296	11,014,778		10,223,167
2050	14,136,655	11,411,630		10,235,834

Figure 9: United Arab Emirates: Total net migration by variants, 1990-2049
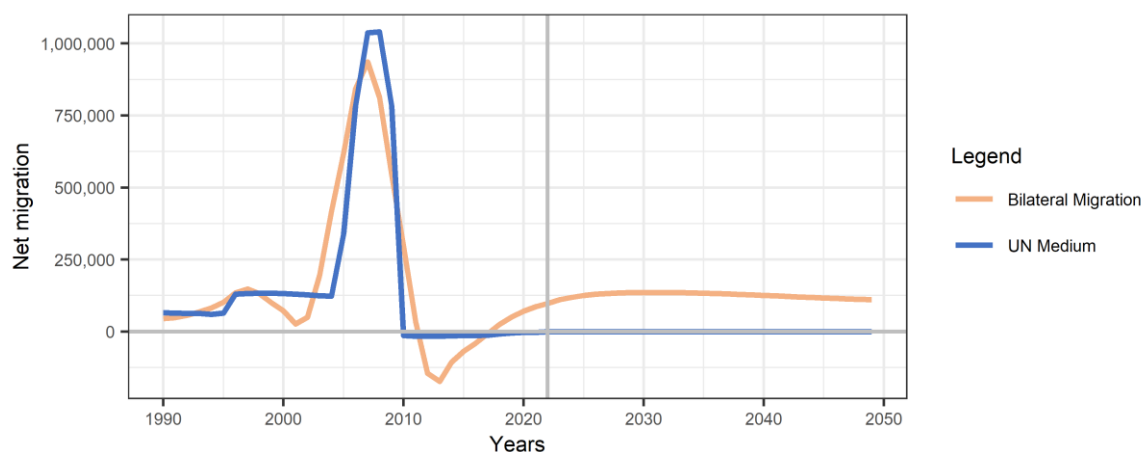
3.2.2.2 Qatar

Qatar is another example of a new immigration country similar to other Gulf States. The number of people living in Qatar is four times higher now than it was in 1990. Most of his rapid population growth was caused by migration. Even on a strictly rotational basis more temporary labour migrants were admitted than sent back home so far. An economic crisis caused by political conflict, an economic boycott and closed borders with its neighbouring Gulf States as well as the effects of CoVid-19 led,

however, to a temporary halt of newly recruited immigrants causing a short population to decline in 2021-22 (-140,000 inhabitants). Like in the UAE, a large majority of people living in Qatar are temporary and predominantly male migrants.

Without further immigration or emigration future population growth would mainly be driven by births of the native Qatari minority (population increase from 2.7 million in 2023 to 3.0 million in 2050). Our projection assumes a resumed immigration and emigration dynamic leading to 3.7 million people living in Qatar in 2050 (+ 1.0 million compared to 2022). The UN (medium variant) projects 3.3 million for the same year assuming smaller net gains from migration.

Qatar does not provide national population projections for the Gulf country.

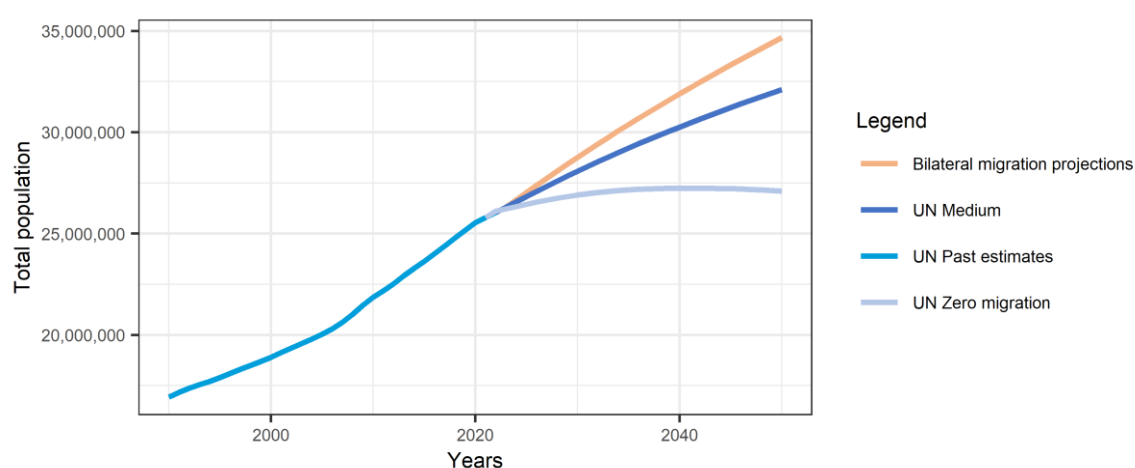**Figure 10: Qatar: Total population by variants, 1990-2050**

Table 6: Qatar: Total population by variants, 2020-2050

Time	Bilateral migration projections	UN Medium	UN Past estimates	UN Zero migration
2020			2,828,630	
2025	2,782,527	2,747,255		2,753,149
2030	2,973,617	2,845,353		2,823,449
2035	3,165,266	2,950,621		2,876,484
2040	3,360,990	3,074,771		2,927,294
2045	3,549,868	3,211,741		2,972,532
2050	3,716,135	3,345,953		2,994,008

Figure 11: Qatar: Total net migration by variants, 1990-2049
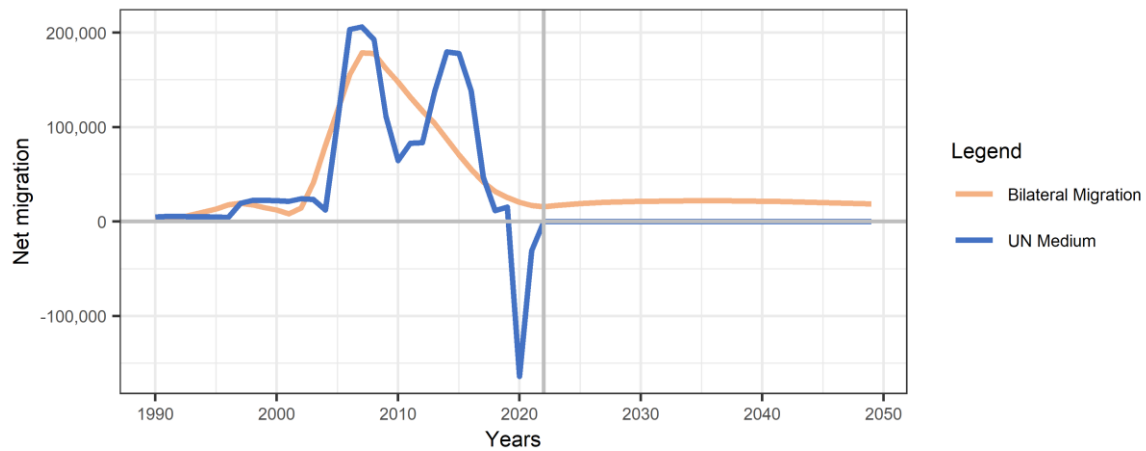
3.2.2.3 Singapore

Singapore is a new immigration country that combines recruitment of temporary labour for the majority of migrants with access to permanent residence and citizenship for selected quota immigrants of Chinese, Malay and Indian ethnic background. Singapore's total population has doubled since 1990 due to massive immigration.

Without future migration this population growth would suddenly come to a halt as Singapore has one of the lowest fertility rates in the world. Until 2050 Singapore's population would drop to 5.4 million (-0.6 million compared to 2020). Even with continuing migration both our projection and the UN medium variant expect that the number of people living in Singapore will peak in the early 2040s at 6.4 million (+ 0.5 million more than in 2020) and then slowly start to decline (2050: 6.3 million). The main reason for this an ever-increasing excess of deaths over births assuming that there will be population ageing but no dramatic increase in fertility.

Despite its developed statistical administration Singapore does not provide national population projections for the South-East Asian country.

Figure 12: Singapore: Total population by variants, 1990-2050
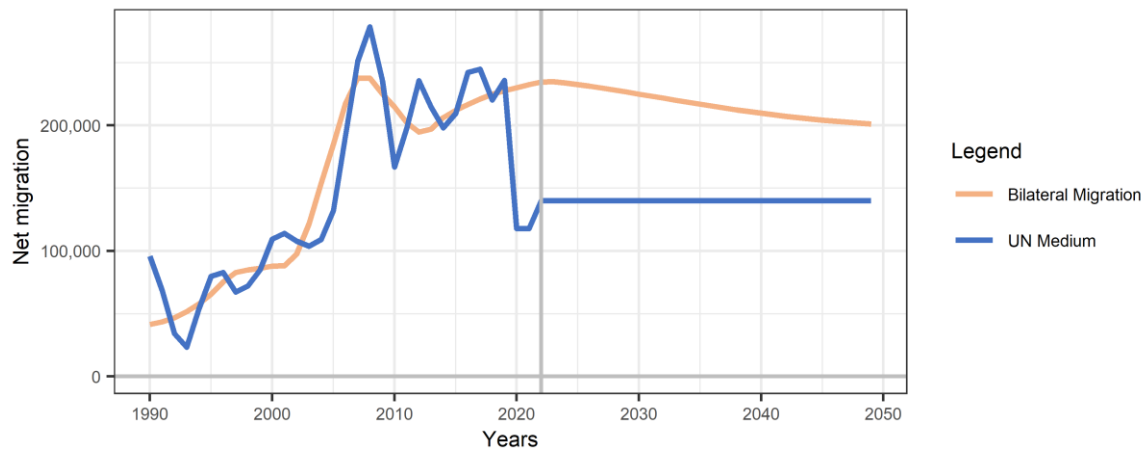
Table 7: Singapore: Total population by variants, 2020-2050

Time	Bilateral migration projections	UN Medium	UN Past estimates	UN Zero migration
2020			5,893,519	
2025	6,074,786	6,071,449		5,993,302
2030	6,233,709	6,237,994		6,008,801
2035	6,334,577	6,354,122		5,959,105
2040	6,372,972	6,406,208		5,834,523
2045	6,354,379	6,398,035		5,644,284
2050	6,292,445	6,344,623		5,407,521

Figure 13: Singapore: Total net migration by variants, 1990-2049
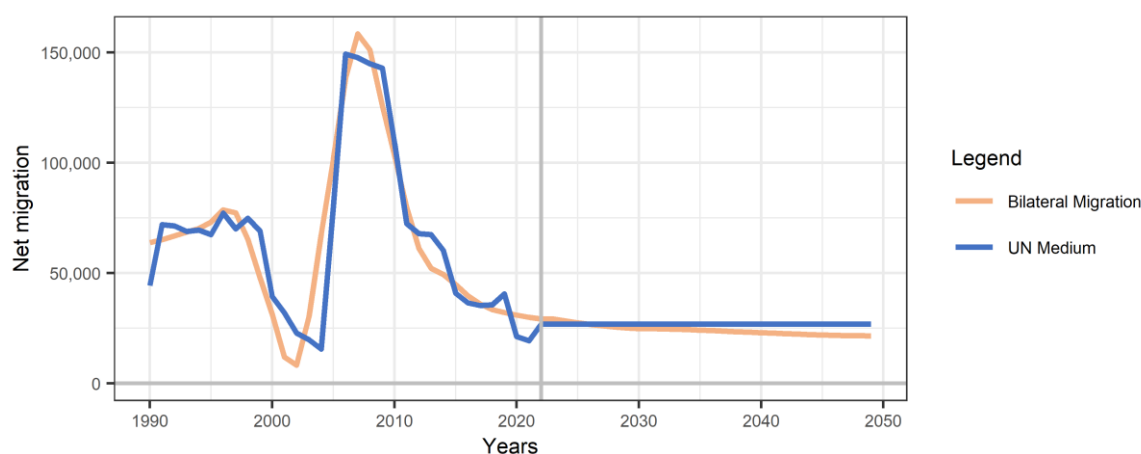
3.2.3 Large countries with net migration gains

Almost all countries of Europe were sending countries until the mid- or even late 20th century. Some are still losing population resulting from a negative migration balance. The majority, however, has turned into net-receiving countries registering more immigrants than emigrants. In absolute terms France, Germany, Italy, Spain and the UK are home or host to the largest number of foreign-born residents.

3.2.3.1 United Kingdom

The UK, one of the world's most important sending country during the 19th and early 20th century has experienced massive inflows since the 1990s. Between 1990 and 2023 the UK population grew by 10 million (almost +20%) which was mainly due to more people entering the UK as migrants than leaving.

Without future migration the UK population would peak at 67.7 million before the end of the 2020s and then start to decline. An ageing population in combination with fertility below replacement level would soon lead to more deaths than births. Without migration the UK, in 2050, would have some 65.7 million inhabitants (-1.3 million compared to 2020).

With immigration and emigration continuing along the trend lines of the past three decades we project the UK population to reach 73.3 million in 2050 (+6.3 million compared to 2020). The UN medium variant assumes a reduced net migration (compared to the past 20 years) and projects that there will be 71.7 million people living in the UK in 2050.

The UK Office for National Statistics assumes continuing net gains from migration and projects the UK's total population to reach 76.6 million in 2046.[13]

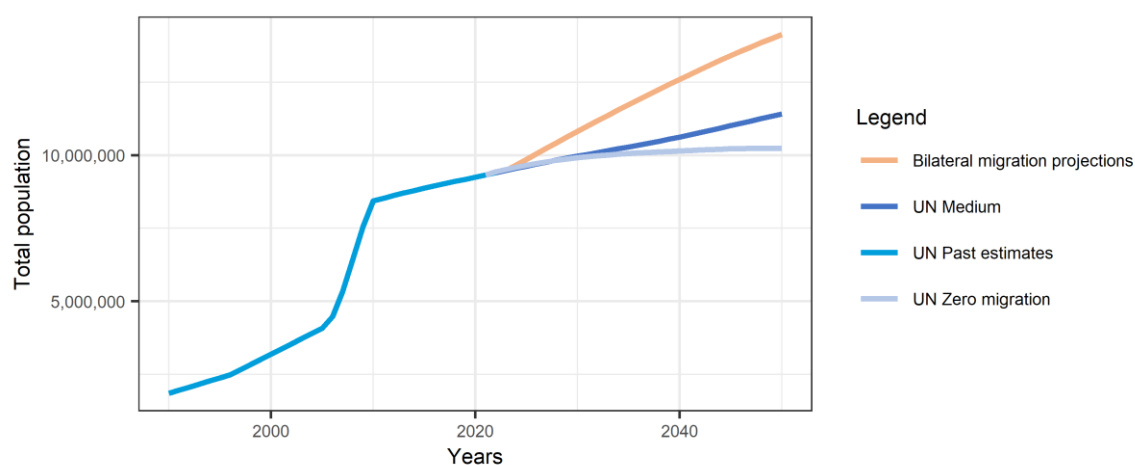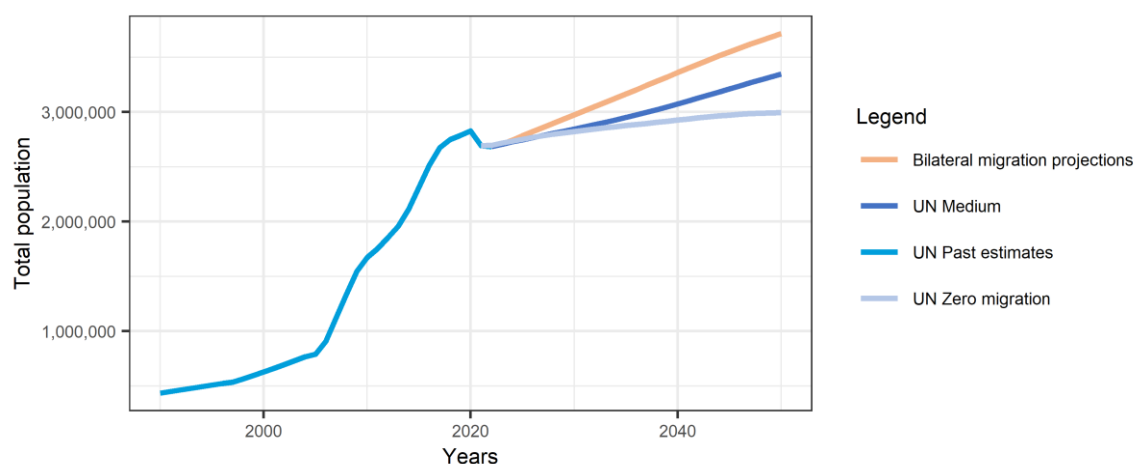**Figure 14: United Kingdom: Total population by variants, 1990-2050**

Table 8: United Kingdom: Total population by variants, 2020-2050

Time	Bilateral migration projections	UN Medium	UN Past estimates	UN Zero migration
2020			66,951,174	
2025	68,199,947	68,072,841		67,583,584
2030	69,534,741	69,086,324		67,643,043
2035	70,680,970	69,919,239		67,429,185
2040	71,686,864	70,623,345		67,018,735
2045	72,580,601	71,238,569		66,471,674
2050	73,275,890	71,659,762		65,691,785

Figure 15: United Kingdom: Total net migration by variants, 1990-2049

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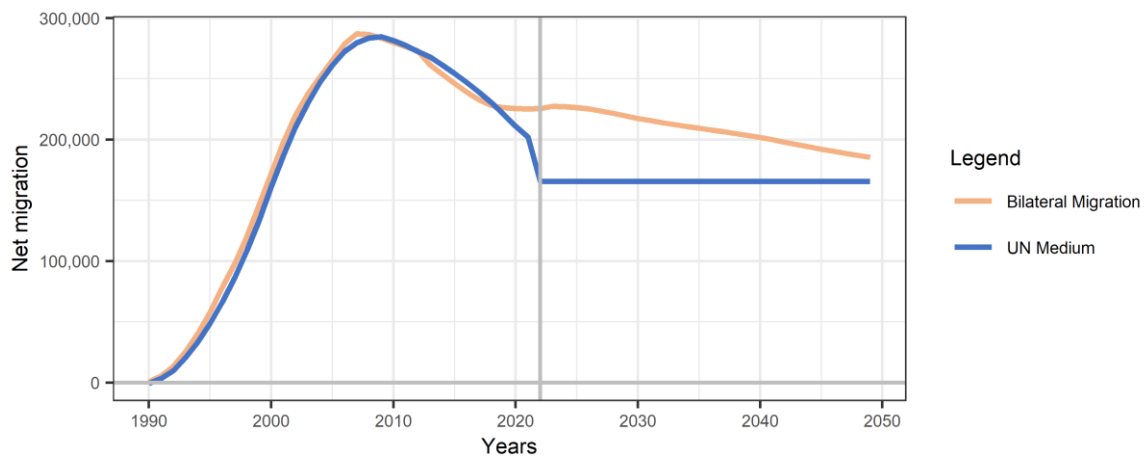
[13] National population projections beyond 2046 are not available;
https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/bull etins/nationalpopulationprojections/2021basedinterim

3.2.3.2 Spain

Despite low fertility Spain experienced considerable population growth during the past three decades. Between 1990 and 2023 Spain's total population rose by about 8 million (+20%). This growth was solely driven by immigration.

Without further immigration Spain's population would start to decline immediately because of the rapidly increasing annual number of deaths and reach 42.8 million in 2050 – the same level as in 2014, but with a much older population. We assume, however, that the immigration and emigration dynamics of the past 30 years will continue. Based on this we project Spain's population to reach 58.6 million in 2050 (+ 11.3 million compared to 2020). The UN medium variant assumes very little future net migration gains and projects a decline of Spain's total population to 44.3 million in 2050 (-3.2 million compared to 2022). Reasons for these restrictive assumptions made in the UN medium variant projection are not made explicit and remain unclear.

The statistical office of the EU uses net migration assumptions and projects Spain's total population to peak at about 58.5 in 2045 million with almost the same population size in 2050.[14]

Figure 16: Spain: Total population by variants, 1990-2050
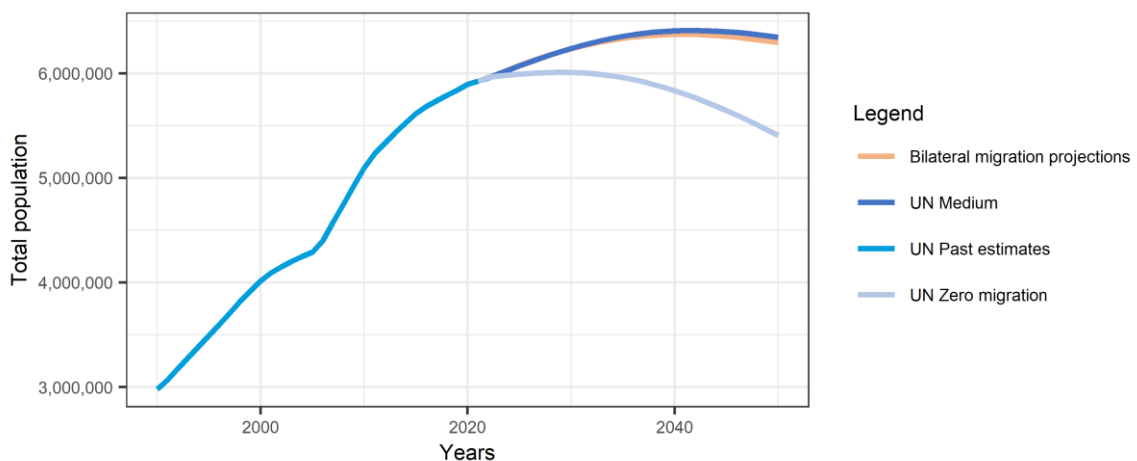

Table 9: Spain: Total population by variants, 2020-2050

Time	Bilateral migration projections	UN Medium	UN Past estimates	UN Zero migration
2020			47,329,954	
2025	48,317,242	47,448,540		47,276,918
2030	50,384,826	47,116,473		46,712,733
2035	52,566,640	46,680,365		46,024,200
2040	54,748,503	46,114,346		45,183,643
2045	56,794,959	45,359,099		44,136,067
2050	58,595,685	44,340,400		42,810,638

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[14] https://ec.europa.eu/eurostat/statistics-explained/index.php?oldid=497115

Figure 17: Spain: Total net migration by variants, 1990-2049
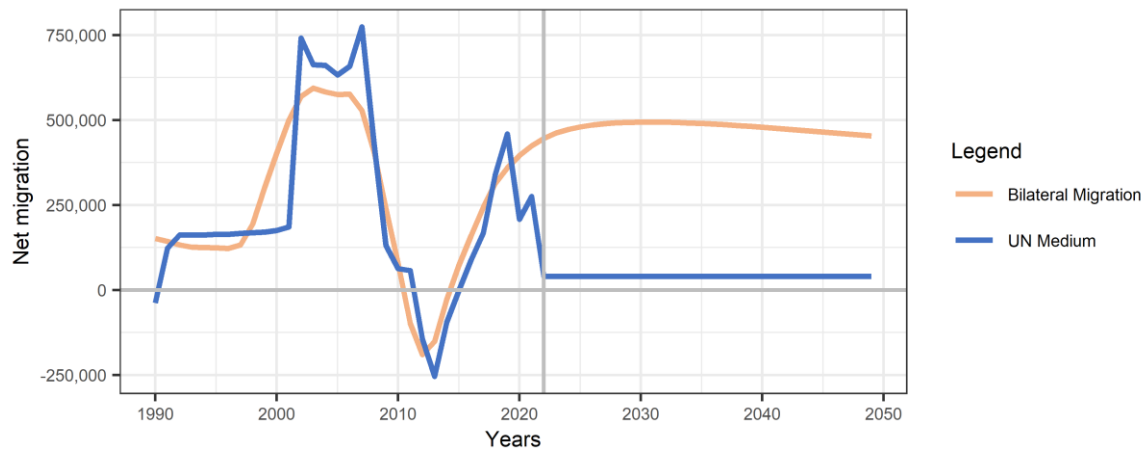
3.2.3.3 Germany

Germany, another key sending country of the 19th century, is Europe's most important receiving and migrants hosting country and the no. 2 at a global scale. Only the USA is home and host to more immigrants. A constant surplus of immigrants over emigrants is the only reason why Germany has a growing population even though there were more deaths than births registered in every single year since 1973. Between 1990 and 2020 the increase was about +5 million. In the absence of future immigration, given the increasing number of deaths, Germany's population would immediately start to shrink from 83.4 million to 73.3. million in 2050 (-10.1 million). We assume a continuation of recent immigration as well as emigration dynamics and project total population to peak at 85 million around the year 2040 (+1.7 million compared to 2022). Beyond 2040 the projection demonstrates that the ever-growing gap between birth and deaths driven by demographic aging will no longer be fully compensated by a positive net balance from migration (2050: 84.6 million). The UN medium variant assumes smaller future net migration gains than during the period 2010-2020 and puts Germany's total population at 79.1 million in 2050 (-4.3 million compared to 2022).

The statistical office of the EU uses net migration assumptions and projects Germany's total population to peak at about 85.3.8 million with a subsequent small decline to 84.8 million in 2050.[15]

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[15] https://ec.europa.eu/eurostat/statistics-explained/index.php?oldid=497115

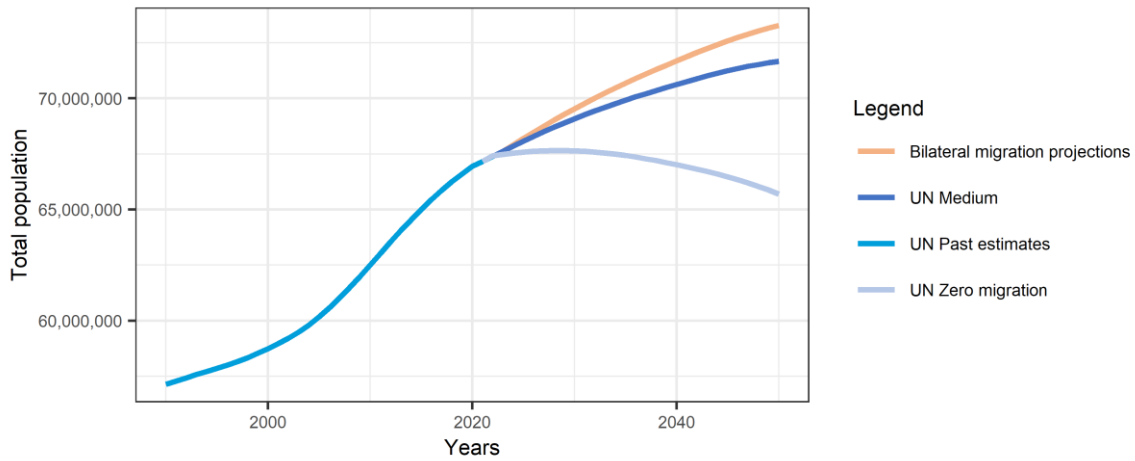**Figure 18: Germany: Total population by variants, 1990-2050**

Table 10: Germany: Total population by variants, 2020-2050

Time	Bilateral migration projections	UN Medium	UN Past estimates	UN Zero migration
2020			83,267,655	
2025	83,717,005	83,228,580		82,640,700
2030	84,513,661	82,820,483		81,332,197
2035	84,932,184	82,154,702		79,672,179
2040	85,055,118	81,297,437		77,761,744
2045	84,938,106	80,270,018		75,635,152
2050	84,574,629	79,064,256		73,306,170

Figure 19: Germany: Total net migration by variants, 1990-2049
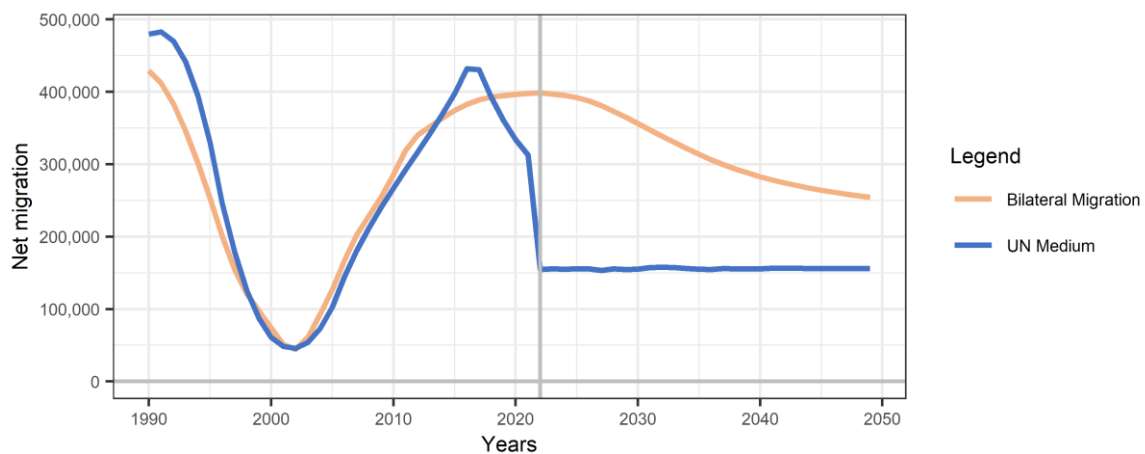
3.2.4   Smaller countries with net migration gains

Not in absolute terms, but relative to population size some of Europe's mid-sized countries clearly are important destinations for migrants. In Austria, Belgium, Ireland, the Netherlands and Sweden they represent 15-20% of total population. In Switzerland the share is even 30%.

3.2.4.1 Sweden

During the past decades the admission of asylum seekers as well as the arrival of people from other EU countries dominated the immigration dynamics. As a result, since 1990, Sweden's total population grew by about 2 million people. In the absence of further migration this population growth would come to an end around 2030 with total population peaking at 10.6 million. After that year an excess of deaths over births would lead to a small demographic decline in the order of 0.2 million. Sweden would then have 10.4 million inhabitants in 2050.

Our projection assumes a continuation of recent immigration and emigration dynamics. As a result, we project Sweden's total population to reach 13.1 million in 2050. The UN medium variant assumes reduced gains from net migration and puts Sweden's total population at 11.9 million in 2050.

The statistical office of the EU uses net migration assumptions and projects Sweden's total population to grow to 12.1 million in 2050.[16]

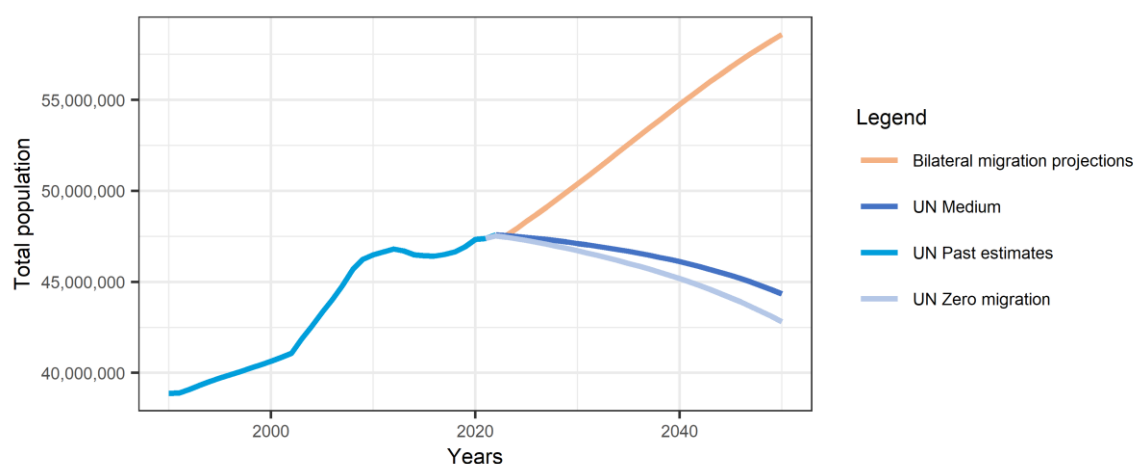**Figure 20: Sweden: Total population by variants, 1990-2050**

Table 11: Sweden: Total population by variants, 2020-2050

Time	Bilateral migration projections	UN Medium	UN Past estimates	UN Zero migration
2020			10,321,414	
2025	10,802,829	10,704,192		10,589,492
2030	11,329,878	10,982,283		10,634,631
2035	11,803,575	11,216,720		10,612,588
2040	12,246,660	11,435,946		10,559,969
2045	12,683,520	11,660,679		10,503,358
2050	13,109,345	11,881,555		10,433,843

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[16] https://ec.europa.eu/eurostat/statistics-explained/index.php?oldid=497115

Figure 21: Sweden: Total net migration by variants, 1990-2049
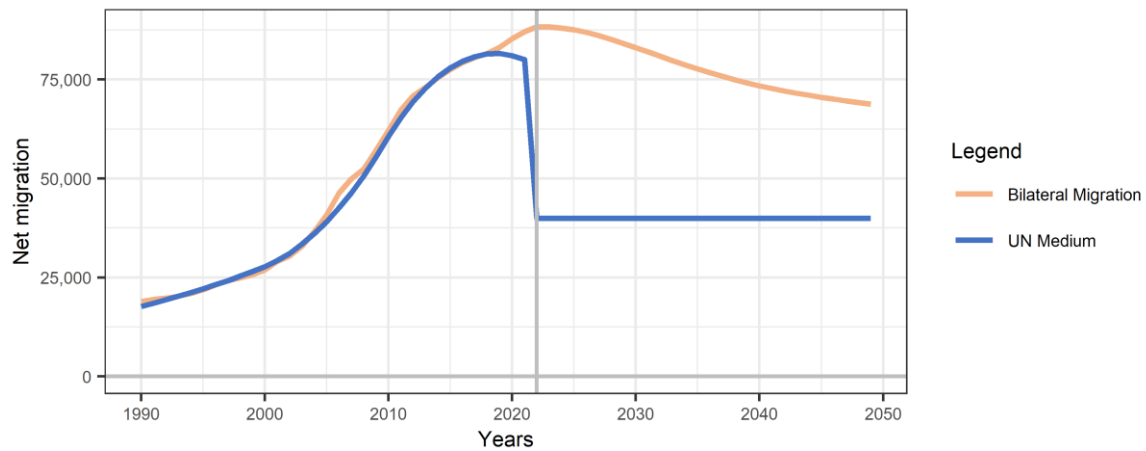
3.2.4.2 The Netherlands

The Netherlands have experienced rapid population growth mostly driven by many more immigrants coming to the country than emigrants leaving. Since 1990 its total population grew by 2.6 million people. Without further immigration the Dutch total population would peak around 2030 at 17.7 million and then decline to 16.8 million in 2050. This decline would be driven by an excess of deaths over births.

Our projection assumes a continuation of recent immigration and emigration dynamics. As a result, a further increase in the number of people living in the Netherlands is projected. In 2050 the Dutch population is expected to reach 18.7 million (+1.2 million compared to 2022). The UN medium variant assumes smaller net gains from future migration. This would lead to a smaller population growth until around 2040 (peak population: 18.1 million) and a subsequent decline to 17.9 million in 2050 (- 0.2 million compared to 2040). This decline would come from the fact that assumed net gains from migration would no longer fully compensate for the increasing gap between growing numbers of deaths and declining numbers of births.

The statistical office of the EU uses net migration assumptions and projects the Netherland's total population to peak at about 18.8 million in 2045 with almost the same population size in 2050.[17]

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[17] https://ec.europa.eu/eurostat/statistics-explained/index.php?oldid=497115

Figure 22: The Netherlands: Total population by variants, 1990-2050
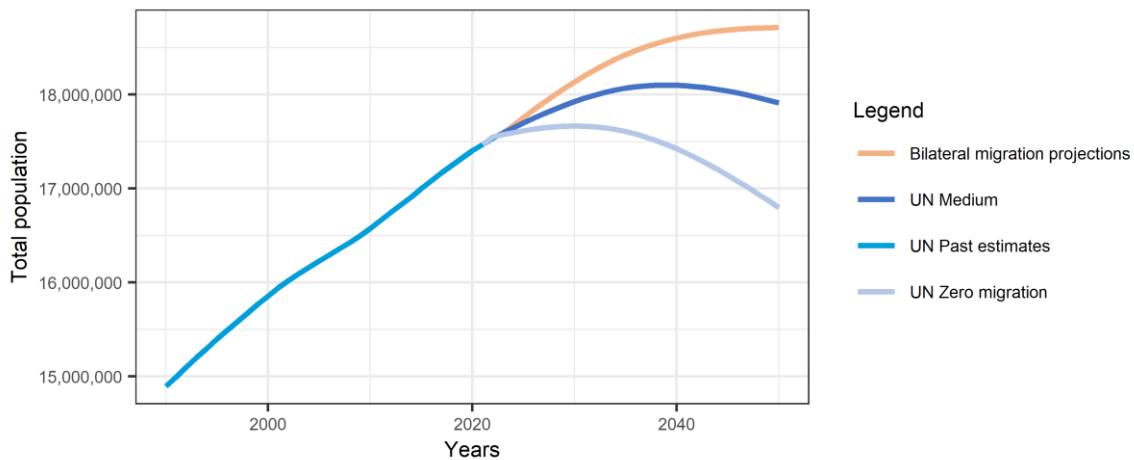
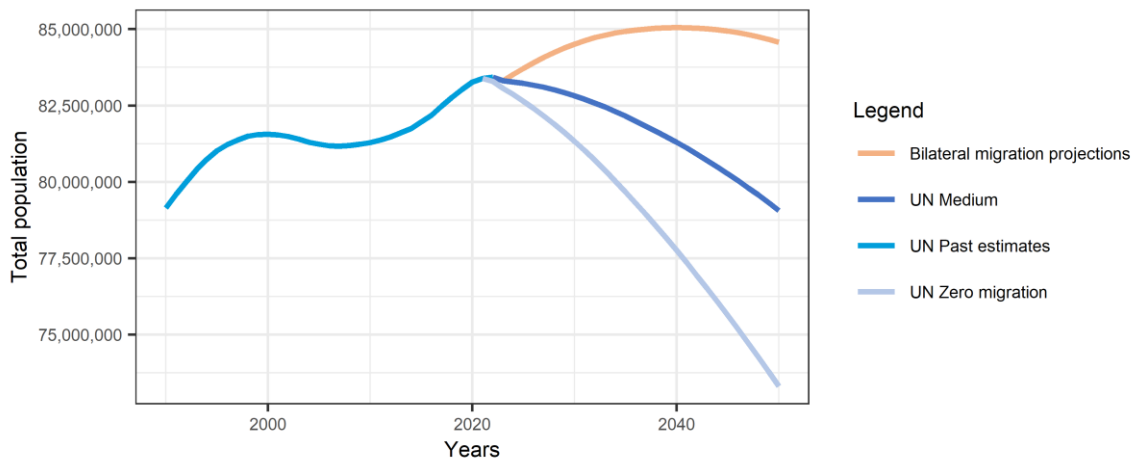**Table 12: The Netherlands: Total population by variants, 2020-2050**

Time	Bilateral migration projections	UN Medium	UN Past estimates	UN Zero migration
2020			17,402,277	
2025	17,756,043	17,697,128		17,614,181
2030	18,135,113	17,925,406		17,665,029
2035	18,425,029	18,068,278		17,606,963
2040	18,601,269	18,099,254		17,423,369
2045	18,687,755	18,037,472		17,142,483
2050	18,713,660	17,912,039		16,797,538

Figure 23: The Netherlands: Total net migration by variants, 1990-2049
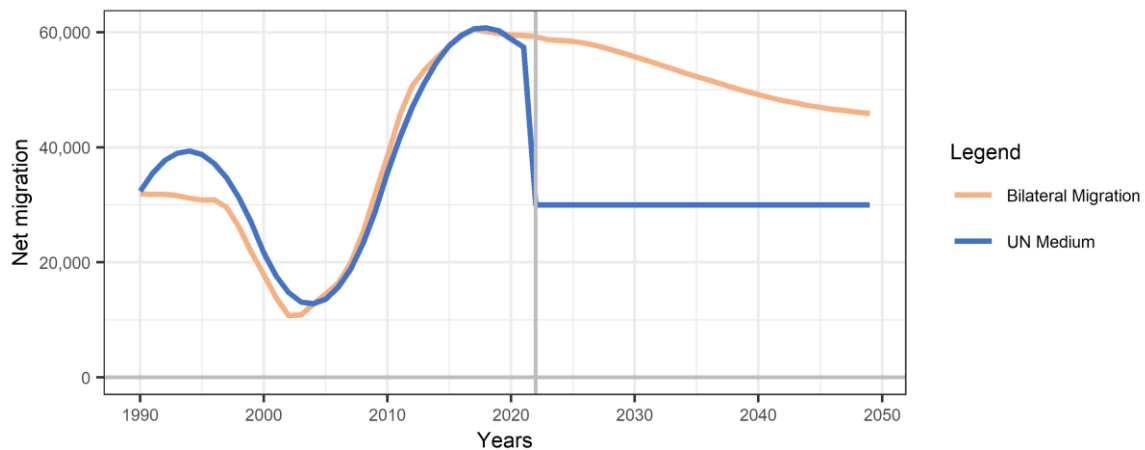
3.2.5   EU countries with net migration losses

Some larger and medium sizes EU countries have already experienced population decline over the past 30 years. Most of them are Central and Eastern European countries. This decline was driven by low numbers of births going hand in hand with an increase in the average age of women at birth during the years of transition from Communism to market economies. Many countries also experienced

considerable emigration as their citizens were gaining legal access to labour markets of other European countries.

3.2.5.1 Croatia

Croatia looks back on a longer history of emigration as it was, until 1991, part of Yugoslavia. This was the only Communist country in Europe that had concluded labour recruitment agreements with countries of Western Europe. The emigration of Croat labour resumed after the country became independent. Once Croatia became member of the EU its citizens gained legal access to labour markets in all other EU and Efts countries. Since the early 1990s Croatia's total population has decreased by about 0.8 million people. This decline was caused by an excess of deaths over births as well as many more people emigrating than moving to Croatia.

It is most likely that Croatia will continue to lose population. In the absence of migration its total population would fall to 3.4 million. When assuming a continuation of past immigration and emigration trends the number of people living in the country is projected to fall to 3.1 million. This is a projected loss of almost 1 million people compared to 2022. The UN medium variant assumes that net losses from migration will become very small reducing the population decline. This puts Croatia's total population at 3.3 million in 2050 (almost the same size as in the zero migration variant). The loss would be 0.7 million compared to 2022.

The statistical office of the EU uses net migration assumptions (with only small losses) also projects Croatia's total population to drop to 3.3 million in 2050.[18]

Figure 24: Croatia: Total population by variants, 1990-2050

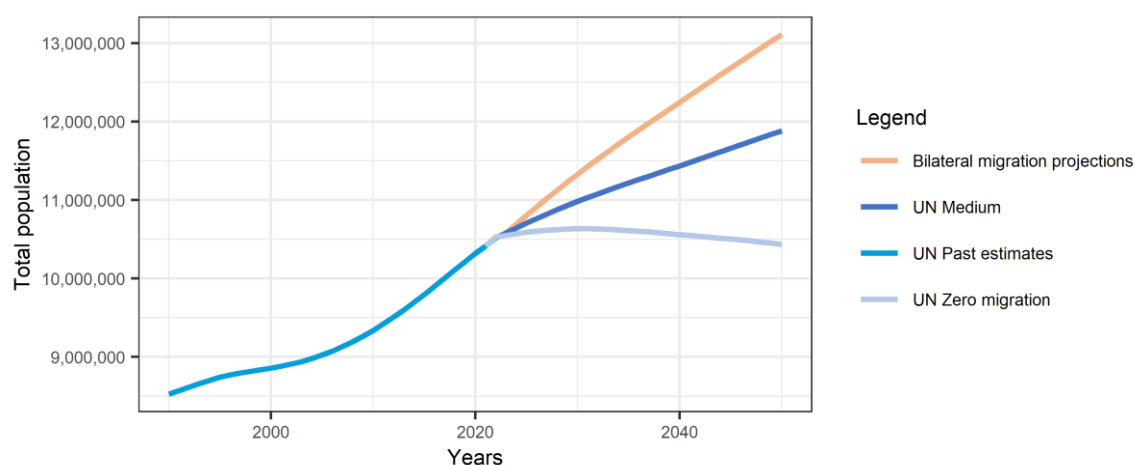**Table 13: Croatia: Total population by variants, 2020-2050**

Time	Bilateral migration projections	UN Medium	UN Past estimates	UN Zero migration
2020			4,114,639	
2025	3,956,075	3,975,565		3,971,577
2030	3,794,191	3,861,825		3,868,492
2035	3,628,357	3,741,852		3,759,951
2040	3,458,612	3,614,125		3,644,686
2045	3,287,638	3,481,069		3,524,991

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[18] https://ec.europa.eu/eurostat/statistics-explained/index.php?oldid=497115

Time	Bilateral migration projections	UN Medium	UN Past estimates	UN Zero migration
2050	3,120,202	3,346,888		3,404,656

Figure 25: Croatia: Total net migration by variants, 1990-2049
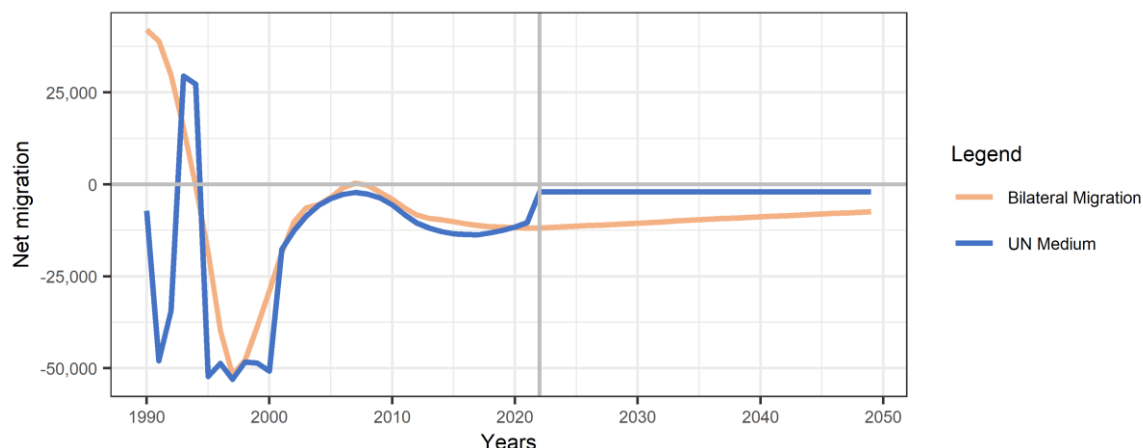
3.2.5.2 Bulgaria

Bulgaria did experience the emigration of ethnic Turks and other Muslims already during Communist times. This type of exodus continued after the end of the Communist regime. Later Bulgarian labour started to emigrate to Northwestern and Southern European countries. This has been facilitated by Bulgaria's accession to the EU. Since 1990 Bulgaria's total population declined by about 2 million people.

Even in the absence of future migration the demographic decline would continue due to a strong excess of deaths over births with total population falling to 5.4. million in 2050. When assuming a continuation of current immigration as well as emigration dynamics the total number of people living in Bulgaria is projected to reach 5.1 million in 2050 (-1.7 million compared to 2022). The UN medium variant projects a similar outcome (2050: 5.2 million).

The statistical office of the EU uses net migration assumptions and projects Bulgaria's total population to drop to 5.9 million in 2050.[19]

Figure 26: Bulgaria: Total population by variants, 1990-2050

[19] https://ec.europa.eu/eurostat/statistics-explained/index.php?oldid=497115

Table 14: Bulgaria: Total population by variants, 2020-2050

Time	Bilateral migration projections	UN Medium	UN Past estimates	UN Zero migration
2020			7,020,235	
2025	6,578,051	6,592,081		6,583,585
2030	6,276,952	6,318,165		6,341,558
2035	5,977,968	6,036,331		6,099,435
2040	5,685,502	5,754,800		5,864,547
2045	5,404,429	5,480,240		5,642,388
2050	5,135,806	5,213,810		5,432,922

Figure 27: Bulgaria: Total net migration by variants, 1990-2049
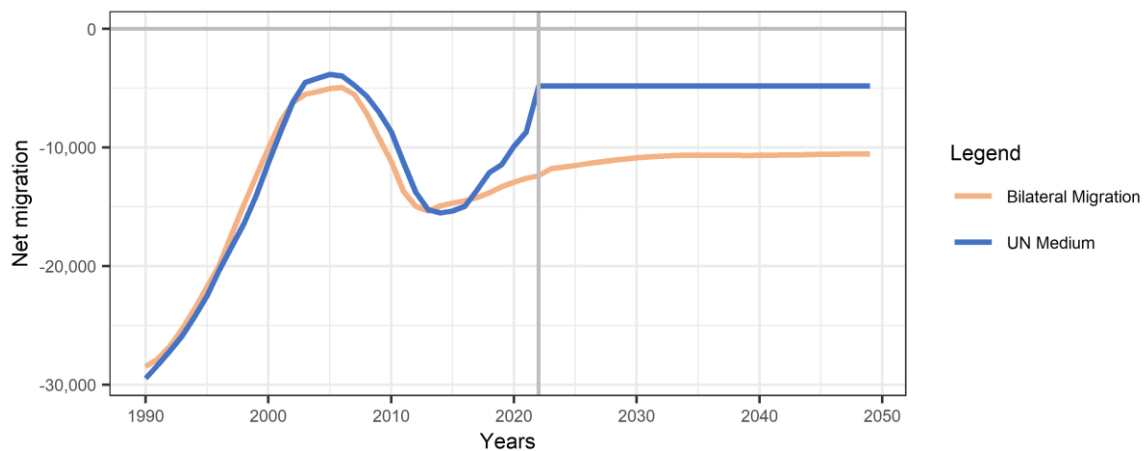
3.2.6 Origin countries with significant migration impact (Maghreb)

Emigration from the Maghreb to Europe, namely France and Spain, started after World War I, but gained momentum in the second half of the 20th century when several Western European and later also Spain started recruiting labour. The outflow and continues to date, but family reunion and marriage migration have become dominant while labour migration has lost its importance. Since 2010 Maghreb countries, namely Morocco and Tunisia (together with Libya) have also become countries of transit and even destination for migrants from sub-Saharan Africa.

3.2.6.1 Tunisia

During the last decades – as a result of sizeable emigration to Europe as well as declining fertility – Tunisia's total population grew at a slower pace. The country's population still increased by 3.7 million since 1990. In the complete absence of migration this growth would continue; and total population would reach 14.5 million in 2050 (+2.1 million compared to 2022). Assuming a continuation of past immigration and emigration dynamics we project Tunisia's total population to only reach 13.8 million in 2050 (+1.5 million compared to 2022). The UN medium variant assumes much smaller net losses from migration and puts the country's total population at 14.3 million in 2050.

Figure 28: Tunisia: Total population by variants, 1990-2050
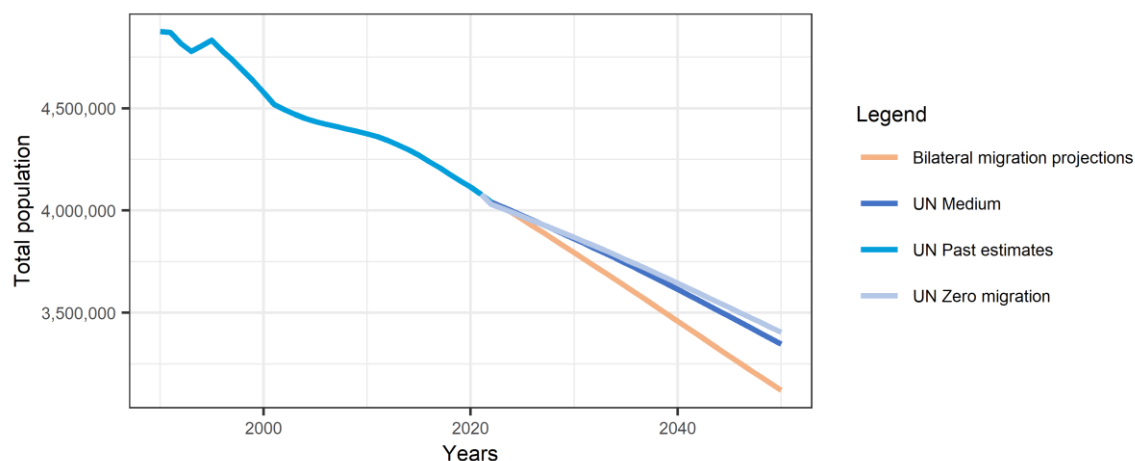

Table 15: Tunisia: Total population by variants, 2020-2050

Time	Bilateral migration projections	UN Medium	UN Past estimates	UN Zero migration
2020			12,106,251	
2025	12,580,975	12,616,469		12,680,137
2030	12,934,303	13,062,543		13,137,158
2035	13,192,147	13,417,304		13,509,822
2040	13,412,044	13,737,780		13,854,200
2045	13,613,466	14,044,057		14,182,217
2050	13,757,944	14,296,074		14,451,244

Figure 29: Tunisia: Total net migration by variants, 1990-2049
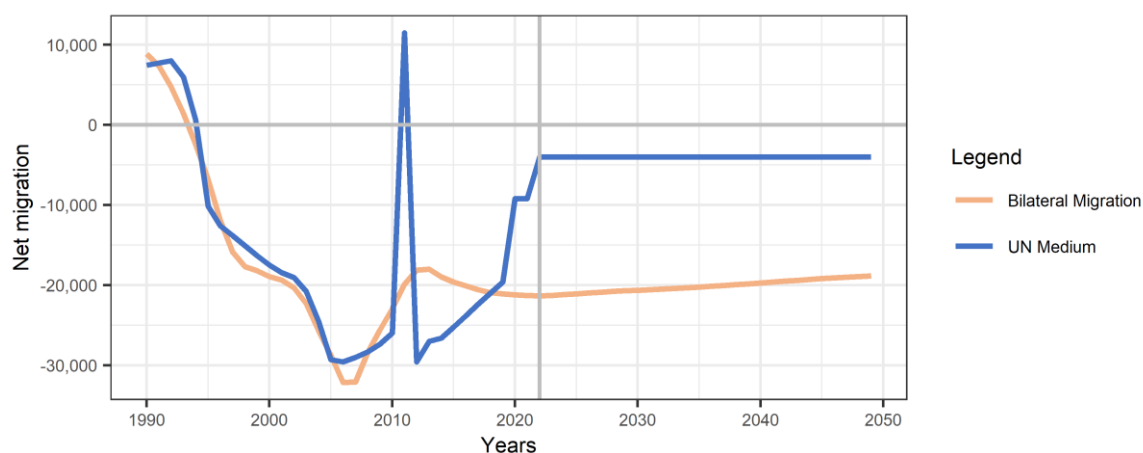
3.2.6.2 Morocco

Morocco's population growth was also reduced by emigration to Europe as well as declining fertility. Then number of people living in this country still increased by more than 12 million people during the past 30 years. In the absence of future migration this increase would continue and the number of people living in Morocco would reach 46.5 million in 2050 (+9.2 million compared to 2022). Assuming a continuation of past emigration dynamics we project Tunisia's total population to only reach 43.7 million in 2050 (+6.4 million compared to 2022). The UN medium variant assumes smaller net losses from migration and puts Morroccos total population at 44.9 million in 2050.

**Figure 30: Morocco: Total population by variants, 1990-2050**

 Table 16: Morocco: Total population by variants, 2020-2050

Time	Bilateral migration projections	UN Medium	UN Past estimates	UN Zero migration
2020			36,488,843	
2025	38,315,155	38,394,302		38,716,797
2030	39,778,728	40,071,053		40,604,320
2035	41,025,728	41,547,658		42,319,602
2040	42,104,736	42,868,608		43,897,977
2045	43,006,848	44,022,836		45,314,743
2050	43,689,532	44,963,808		46,522,496

Figure 31: Morocco: Total net migration by variants, 1990-2049
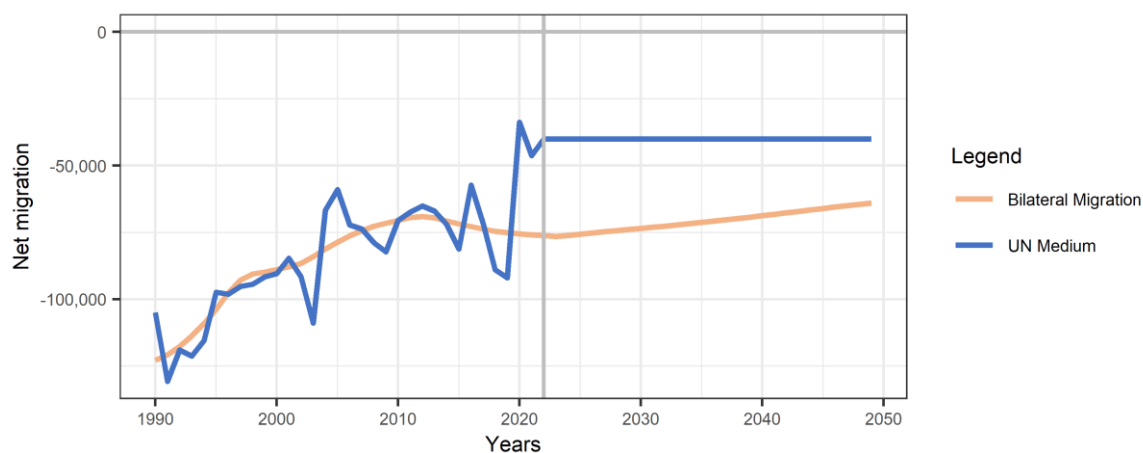
3.2.6.3 Algeria

Algeria is the Maghreb's most populous country. During the 20th century it has experienced the emigration of Algerian labour as well as a mass exodus of people with European roots in 1961-62 when the country became independent. In recent years marriage migration and family reunion have become the most important legal of Algerian's moving to Europe. Algeria's total population grew by 18 million between 1990 and 2022. Population growth is assumed to continue. In the absence of any future migration Algeria's total population would reach 60.4 million in 2050 (+15.9 million compared to 2022). By assuming a continuation past migration trends, we project some 58.7 million people living in Algeria in 2050 (+14.2 million compared to 2022). The UN medium variant assumes only very small net migration losses and puts Algeria's total population at 59.8 million in 2050.

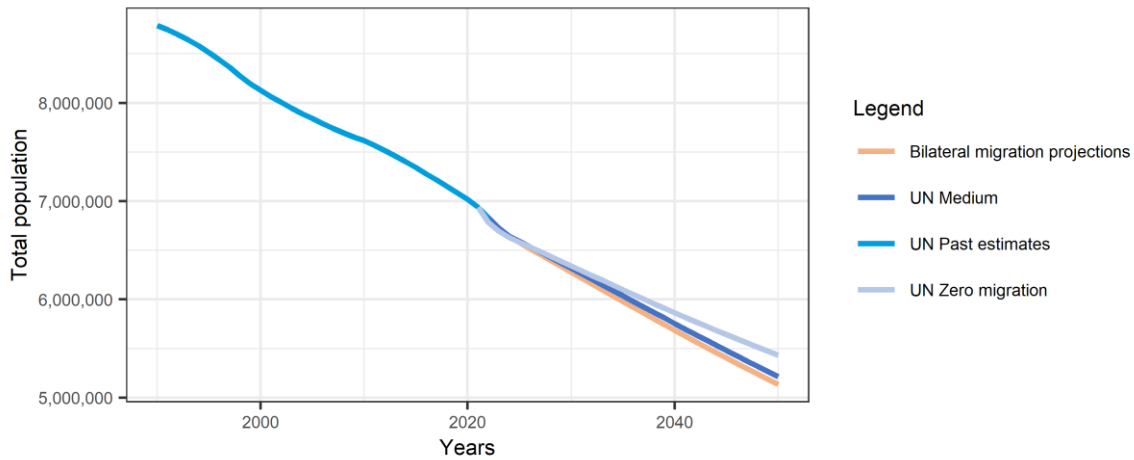**Figure 32: Algeria: Total population by variants, 1990-2050**

Table 17: Algeria: Total population by variants, 2020-2050

Time	Bilateral migration projections	UN Medium	UN Past estimates	UN Zero migration
2020			43,090,987	
2025	46,551,598	46,607,400		46,958,734

Time	Bilateral migration projections	UN Medium	UN Past estimates	UN Zero migration
2030	49,311,431	49,522,550		49,883,938
2035	51,713,302	52,099,174		52,516,353
2040	54,073,462	54,656,825		55,152,817
2045	56,465,486	57,273,460		57,842,676
2050	58,715,187	59,771,863		60,385,442

Figure 33: Algeria: Total net migration by variants, 1990-2049
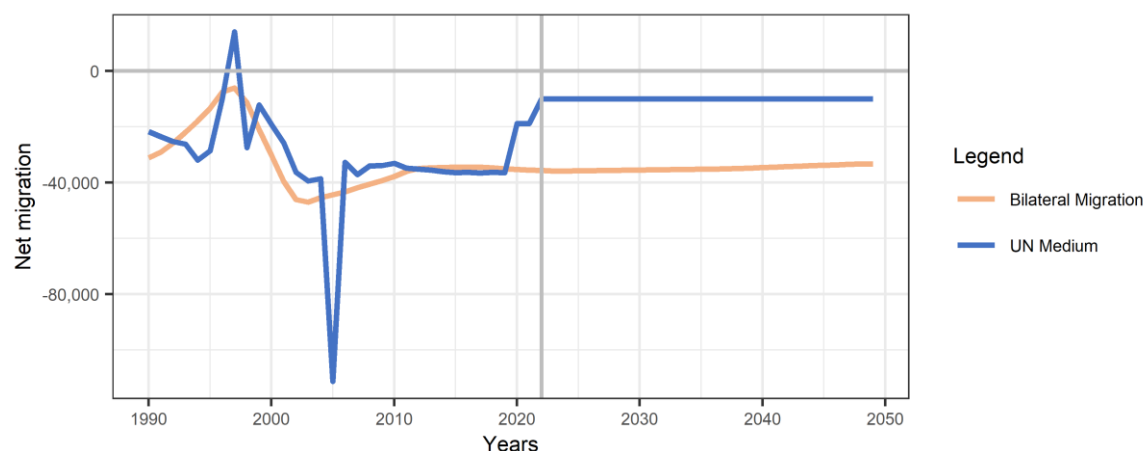
3.2.7   Origin countries with small migration impact

South Asia has a fairly long emigration tradition as – during colonial times – the British rulers organized the "export" of (initially endentured) labour to other parts of the British Empire: namely to South and East Africa, the Caribbean and Guyana, Malaysia, and the Fiji Islands. In the 20th century South Asians also started to migrate to the UK, the US, Canada and since 1973 also to Australia. More recently South Asians have been and still are admitted by most Gulf States as temporary labor migrants.

3.2.7.1   Pakistan

Pakistan is an important sending country with the Gulf States being the most important destination. In the recent past this has reduced the pace of population growth driven by a considerable excess of births over deaths. Between 1990 and 2020 Pakistan's population grew by 115 million people. This growth will most likely continue. Without further migration Pakistan's total population would reach 374 million in 2050 (+140 million compared to 2022). Assuming a continuation of past migration trends we project a lower total population due to net migration losses (2050: 325 million; 91 million compared to 2022). The UN medium variant assumes much smaller net losses from migration and puts Pakistan's total population at 366 million in 2050.

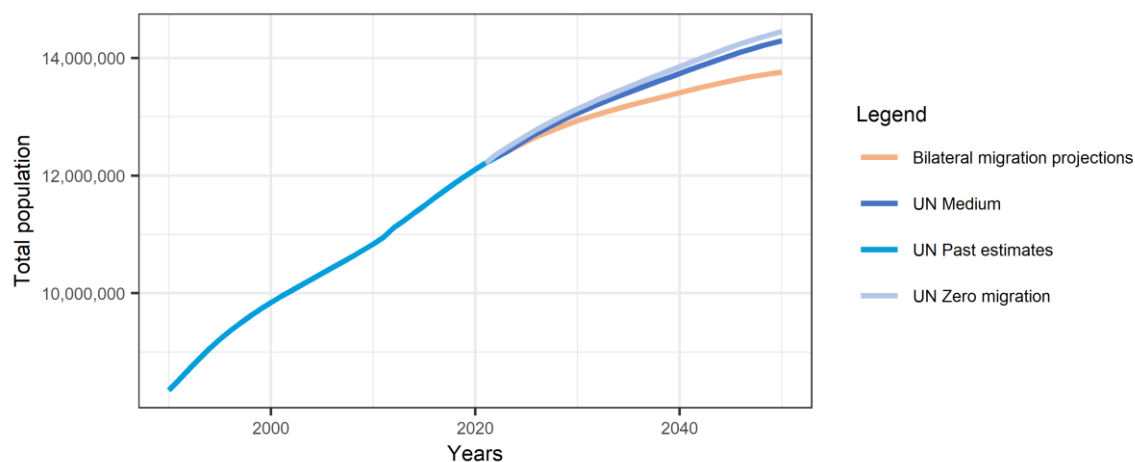**Figure 34: Pakistan: Total population by variants, 1990-2050**

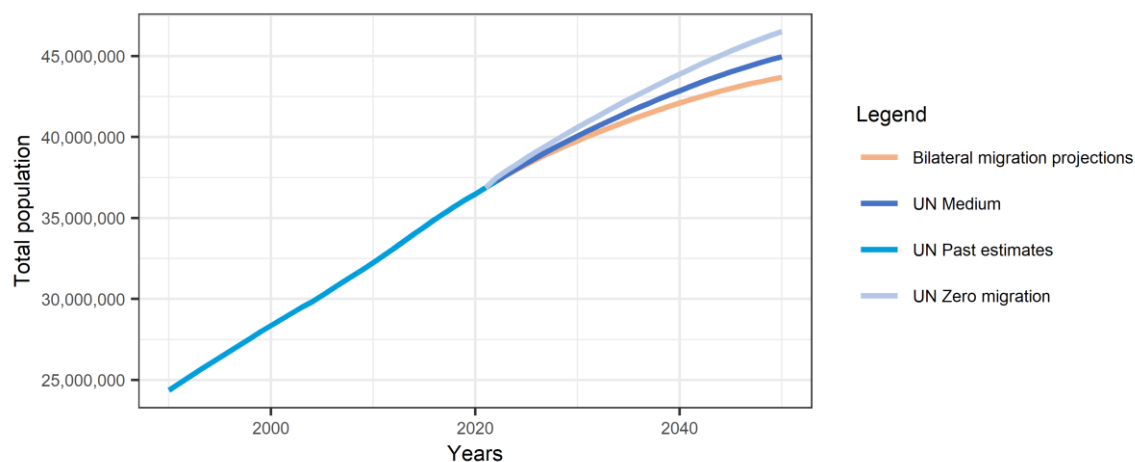**Table 18: Pakistan: Total population by variants, 2020-2050**

Time	Bilateral migration projections	UN Medium	UN Past estimates	UN Zero migration
2020			225,112,860	
2025	244,944,428	247,574,429		250,552,577
2030	261,940,003	271,601,627		275,590,707
2035	278,785,449	295,989,502		301,024,919
2040	295,188,418	320,225,830		326,245,528
2045	310,485,071	343,548,326		350,524,359
2050	324,349,473	365,677,838		373,575,030

Figure 35: Pakistan: Total net migration by variants, 1990-2049
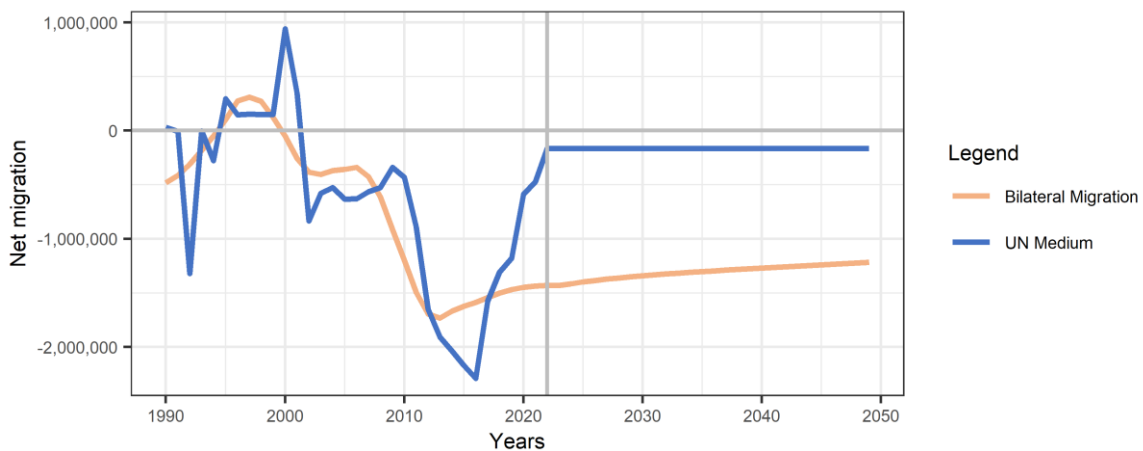
3.2.7.2 India

India is not only the world's most populous nation. In absolute terms India is also one of most important sending countries. At the same time India is the destination of migrants mainly from Bangladesh and Nepal. Compared to its total population size both immigration and emigration play almost no role. In the absence of future migration India's total population would grow to 1.69 billion in 2050 (+276 million compared to 2022). By assuming past immigration and emigration trends to continue we project a total population of 1.67 billion in 2050 (+256 million compared to 2022). For the

same year the UN medium projects a similar population size. Despite a difference of 20 million people in the result without migration the overall demographic impact of emigration from and immigration to India is minimal.

Despite its developed statistical administration India does not provide national population projections for the South Asian country.

Figure 36: India: Total population by variants, 1990-2050

Table 19: India: Total population by variants, 2020-2050

Time	Bilateral migration projections	UN Medium	UN Past estimates	UN Zero migration
2020			1,389,966,38	
2025	1,448,304,01	1,448,210,90		1,456,374,35
2030	1,509,442,14	1,509,296,26		1,519,567,61
2035	1,563,031,66	1,562,950,12		1,575,450,23
2040	1,607,766,03	1,607,764,16		1,622,578,58
2045	1,642,835,64	1,642,937,02		1,660,091,37
2050	1,668,370,74	1,668,474,58		1,688,111,53

Figure 37: India: Total net migration by variants, 1990-2049
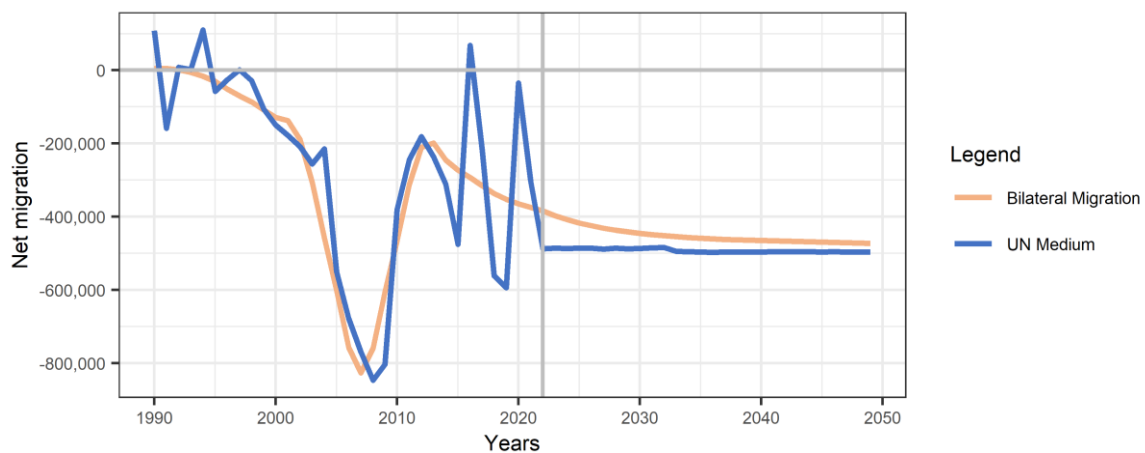
3.2.7.3 Bangladesh

Emigration from Bangladesh takes place both towards the Gulf States and towards India. Other destinations play smaller roles. In the recent past this has reduced the pace of population growth driven by an excess of births over deaths. Between 1990 and 2020 Bangladesh's total population increased by +64 million people. This growth will continue during the 21st century. In the absence of further migration Bangladesh's total population would reach 214 million in 2050 (+43 million compared to 2022). Assuming a continuation of past migration trends we project a lower total population due to net migration losses. In 2050 the total population if this country is projected to reach 202 million (+31 million compared to 2022). The UN medium variant assumes similar net losses from migration and puts Pakistan's total population at 204 million in 2050.

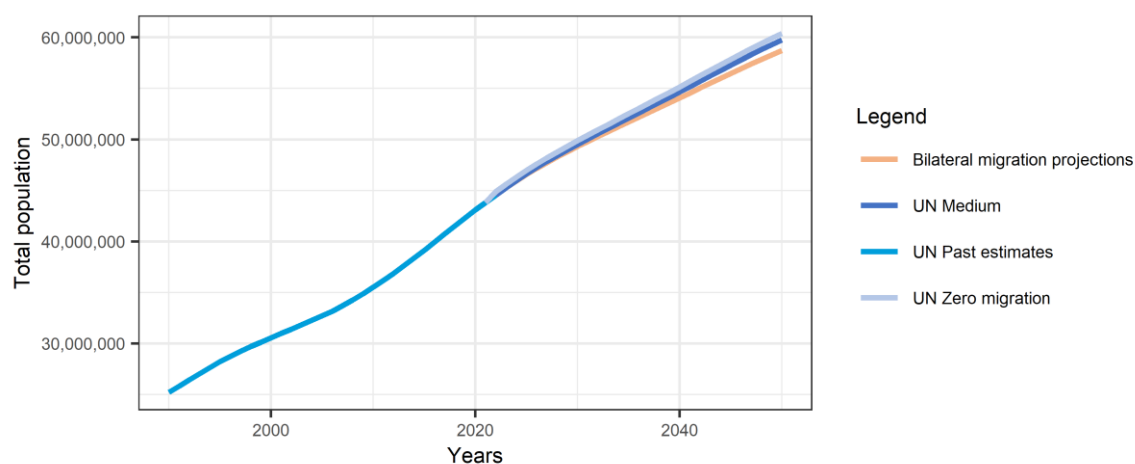**Figure 38: Bangladesh: Total population by variants, 1990-2050**
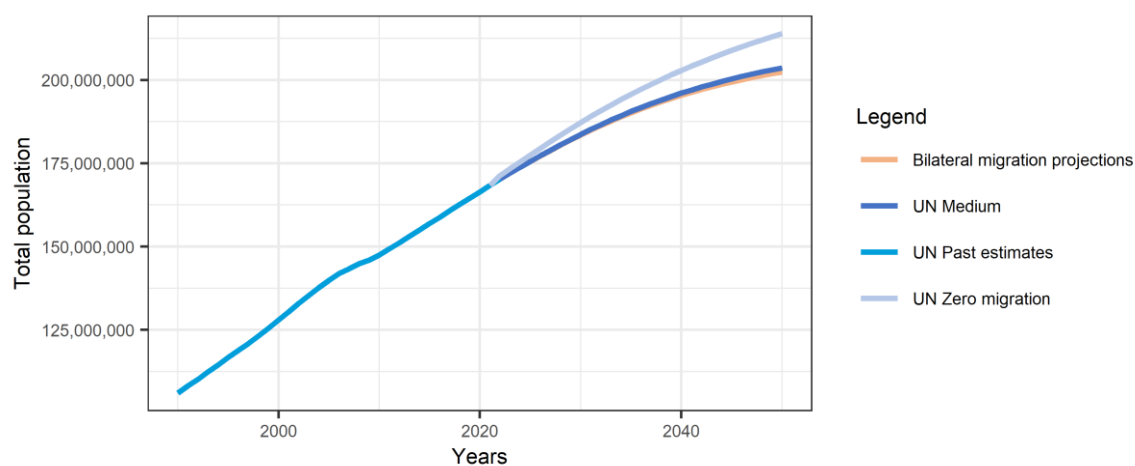
Table 20: Bangladesh: Total population by variants, 2020-2050

Time	Bilateral migration projections	UN Medium	UN Past estimates	UN Zero migration
2020			166,426,993	
2025	175,540,942	175,568,935		177,530,965
2030	183,501,141	183,684,728		187,217,591
2035	190,162,120	190,560,673		195,721,321
2040	195,414,482	196,054,988		202,878,327
2045	199,417,394	200,340,371		208,880,942
2050	202,374,086	203,638,097		213,928,864

Figure 39: Bangladesh: Total net migration by variants, 1990-2049
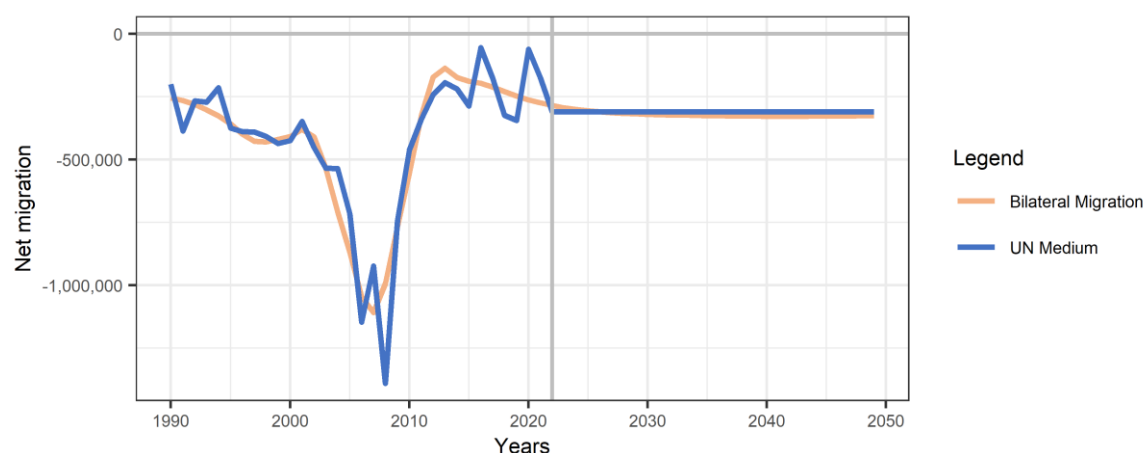
3.3 Population Projections: Country Groups

Population projections for individual countries can be aggregated into larger composite entities. In this case, migration flows refer to the sum of all countries, hiding internal disparities: negative net migration for some countries may be compensated by other countries of the group, and vice versa. The same holds for overall population size.

3.3.1 European Union (EU27)

The European Union currently consists of 27 member states. A combined analysis shows a clear increase of total population during the past 3 decades from 419 million to 447 million inhabitants in 2022 (+28 million). Initially an excess of births over deaths contributed to this growth. But since 2013 the number of deaths is larger than the number of deaths making population growth (or decline) totally dependent on net gains from migration. In 2020-2021 this led to a small decline of total population as CoVid19-related measures led to smaller inflows. In 2022 the inflow of more than 5 million Ukrainians – of which 3.8 million remained in an EU country – overcompensated this short drop pushing the number of people living in EU27 over 450 million.

In Europe (EU27), the number of deaths will increase as the baby boomer generation now enters retirement and will pass away during the next decades. When assuming a continuation of past immigration and emigration dynamics the net gain from migration will overcompensate the demographic loss driven by increasing mortality until the mid-2030s. As a result, the total number of people living in the EU27 will peak at 454 million and then gradually shrink to 449 million in 2050 (-6 million compared to 2035).

Without further immigration – the number of people living in the EU would dramatically shrink. The WPP (variant without migration) projects 403 million inhabitants in 2050.[20] But even with the moderate net gains from migration assumed in the WPP main variant the EU population is projected to decline to 424 million in 2050 (-26 million compared to 2022).

The statistical office of the EU uses net migration assumptions and projects the EU population to peak at 453 million already in 2026 and then slowly decline to 447 million in 2050.[21]

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[20] As the UN's projection without net migration starts on 1. of January 2022, it does not include net migration gains in 2022-23. This means that Ukrainians displaced by Russia's war against their country are not included in the no-migration variant (see Figure 40).

[21] https://ec.europa.eu/eurostat/statistics-explained/index.php?oldid=497115

Figure 40: European Union (EU27): Total population by variants, 1990-2050
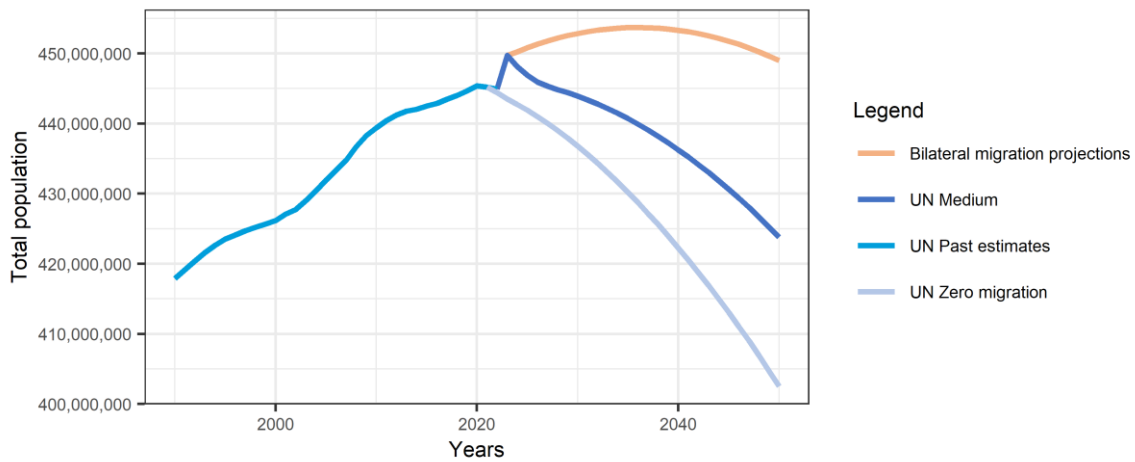
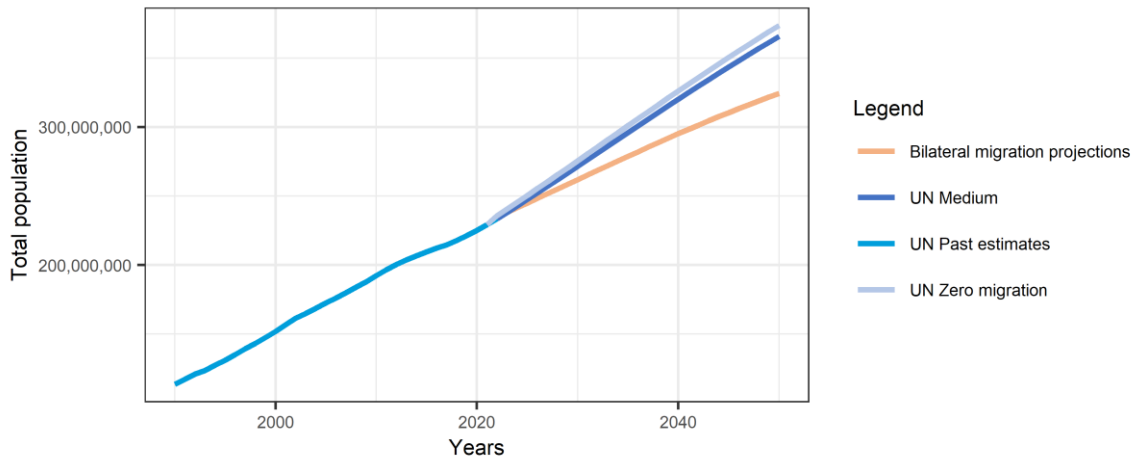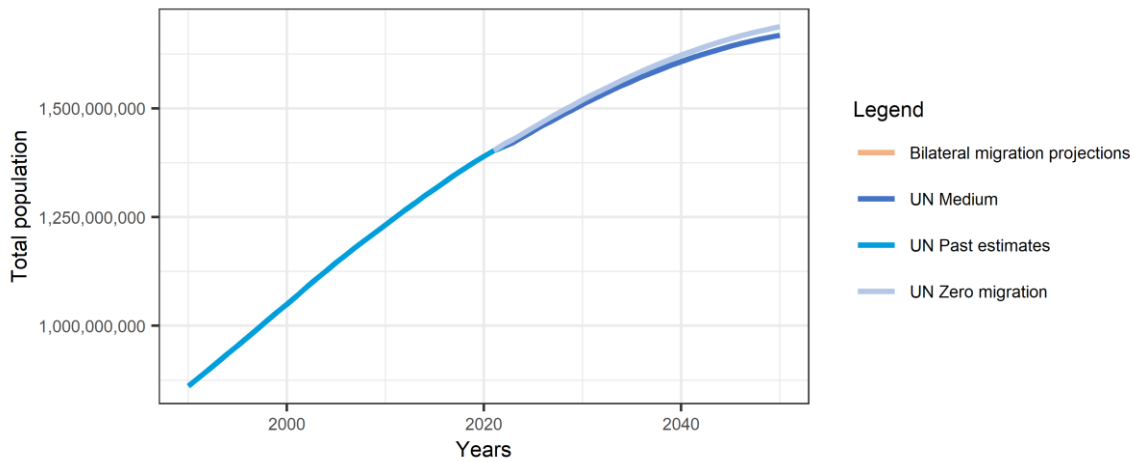**Table 21: European Union (EU27): Total population by variants, 2020-2050**

Time	Bilateral migration projections	UN Medium	UN Past estimates	UN Zero migration
2020			445,390,236	
2021			445,190,667	445,190,667
2022	444,911,668	444,911,668	444,911,668	444,405,706
2023	449,720,109	449,720,109		443,503,169
2024	450,249,697	448,124,320		442,716,085
2025	450,812,272	446,882,930		441,899,658
2030	452,860,703	443,924,537		436,793,750
2035	453,689,513	440,703,334		430,181,189
2040	453,314,809	436,246,722		422,255,384
2045	451,763,150	430,631,320		413,058,307
2050	449,001,100	423,820,806		402,518,055

Figure 41: European Union (EU27): Total net migration by variants, 1990-2049
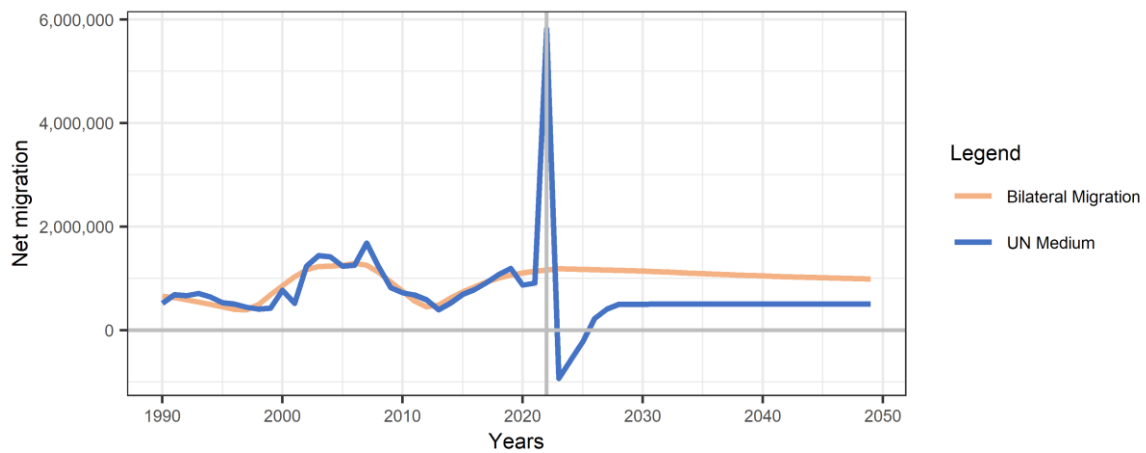
4   Conclusions

All population projections are based on assumptions about future trends in fertility, mortality and spatial mobility. Forecasting fertility and mortality is facilitated by two factors. On the one hand for the majority of countries data are available. On the other hand (in most cases) changes over time are gradual and trends can more easily be identified. Assumptions about future spatial mobility are, however, more difficult to make. The range of uncertainty is much larger (see Barker and Bijak 2021; Bijak and Czaika 2020).

4.1   Data problems

Globally only about 50 countries collect and publish useful statistical data on international migration (Buettner 2023). But even receiving countries that collect data give more accurate information about immigration flows and the total stock of migrants than about emigration. And in sending countries with available statistics emigration is also underreported. As a result, net migration gains or losses are often used as a proxy for the unknown or not sufficiently documented flows. This "second best solution" is calculated as a residual when changes in total population as well as the number of births and deaths is known.[22] Most population projections continue to employ the concept of net migration (Eurostat, UN Population Division, US Census Bureau) or, in the case of Lutz, Butz, and KC (2014) as well as Lutz et al. (2019), a migrant pool model. In both approaches, the underlying demographic dynamics are not captured (Buettner and Muenz 2016).

On the one hand, relying on net migration is a useful workaround in the absence of more complete data. On the other hand, however, the residual calculation adds to uncertainty as very different flow volumes can result in the same net migration. In the end, past and present immigration vs. emigration dynamics cannot really be understood by looking at net migration. In that case it is not just the future that is unknown, but also actual migration dynamics of the recent past remain obscured when applying the concept of net migration. For example: actual gross migration flows into and out of a Gulf State with low net migration sharply differ from flows in a Sahel country with similar net volumes. Already in 1990, Andrei Rogers wrote a requiem for "net migrants, a non-existing category of individuals" (Rogers 1990, 283). However, for reasons described above, demographers continue to use the concept of "net migration" when formulating assumptions for international population projections. Rogers' requiem, it seems, was performed for something holding quite successfully onto life.

4.2   Incidence and prevalence, reversible vs. irreversible events

Mortality data capture a universal phenomenon. We are all mortal. Every person sooner or later passes away. Fertility data relate not to all women, but to a majority of them. Until age 45, between 70% and 90% of women belonging to a cohort give birth to a child. What varies between countries is rather the average number of children and the mean age of mothers when giving birth. And births as well as deaths are binary events shaping the size and age distribution of populations. People are born, are alive and die at a given moment in time. While the size of cohorts may differ, the underlying fertility and mortality trends are usually stable and therefore easier to anticipate. As a result, in "normal" times (i.e. in the absence of war or epidemics) demographic projections are fairly accurate when migration has no significant impact.

Migrant status, however, is reversible and usually relates to a minority. A large majority of people never experience spatial mobility across international borders. Usually only 10 to 15% of all people

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[22] The residual method to calculate net migration is: total population change during a defined period (usually a calendar year) plus births minus deaths.

living on our planet ever move to another country for an extended period of time. All international migration events are the result of decisions taken by this minority. From a stochastic point of view this already makes international migration more volatile.

Through their mobility across borders people become international migrants during their lifetime which makes them part of the foreign-born population of a given country at a certain moment in time. This makes them part of yet another minority. There are only very few countries (e.g. Qatar, United Arab Emirates) with a majority of foreign-born people among its resident population. When people living outside their country of birth re-migrate this status no longer applies. A return flow therefore reduces the stock of migrants. As a result, it is not just the volume of past migration flows, but also the duration of stay (and the migrant specific mortality) which explains the stock of international migrants.

From a demographic point of view most of the uncertainty about future population size and composition comes from the effect of international migration driven by the mobile minority of people. This is true both for sending and receiving countries.

4.3   Types of flows

Some migration flows are steadier than others. For Europe this can be exemplified when looking at time series of different types of first residence permits issued by EU member states and other pathways.

- The annual number of non-EU citizens admitted for marriage or classical family reunion had the lowest volatility. It varied between 433,000 (2013) and 773,000 (2022) and displayed an upward trend.[23]

- The number of people admitted for work and employment reason was more volatile. It declined starting in 2010 reaching its lowest level at 175,000 in 2015. After 2016 numbers of admitted labour and skills rose again reaching 843,000 in 2022.[24]

- The inflow of asylum seekers was even more volatile. Starting from low levels in the mid-2000s the flow reached a first peak in 2015-16 when first asylum requests reached 1.2 million in both years. During the following years annual numbers dropped to 417,000 in 2020 (a low number which can partly be explained by the effects of CoVid-19 related border closures and travel restrictions). In 2023 the number was back to a level above 1 million first asylum requests.[25]

- The most important single flow occurred in 2022 when over 5 million Ukrainians displaced by the Russian invasion of their country arrived in the EU and were given temporary protection status. 3.8 million of them remained in an EU country until the end of that year.[26]

The European example is based on fairly solid data provided by countries with high statistical standards. It demonstrates that it is almost impossible to model and forecast flows of asylum seekers

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[23] Only first permits issued for a period of 12 or more months are considered. People entering an EU country for less than 12 months are not considered as "migrants". Data source:
https://ec.europa.eu/eurostat/web/migration-asylum/asylum/database
[24] Only first permits issued for a period of 12 or more months are considered.
[25] https://ec.europa.eu/eurostat/web/migration-asylum/asylum/database
[26] https://home-affairs.ec.europa.eu/policies/migration-and-asylum/common-european-asylum-system/temporary-protection_en

and other people seeking protection. A one-of like the inflow of millions of Ukrainians can only be anticipated by horizon scanning techniques.[27]

4.4   From somewhere or from anywhere?

Over time, some migration corridors become less relevant (e.g., Mexico-USA) or almost disappear (e.g., Turkey-Germany); others emerge (e.g., India-UAR). Population projection done at national or regional level do not need to capture such changes. As the future geography of flows by corridors is uncertain, the underlying model of the projection can treat immigrants as coming from anywhere ("rest of the world") and emigrants moving to the "rest of the world". Global population projections, however, need to have an aggregate net migration balance close to zero. In the underlying projection model all migrants need to come from somewhere.

In 1993, David Plane published another requiem, trying to bury the fixed-transition-probability migrant (Plane 1993). Here, the critique of conventional approaches to modeling migration is taken one step further. Plane argues that, although migration in multiregional models is formulated (in a broad sense) as flows, the models assume constancy of emigration rates (or fixed transition probabilities) and thus neglect the interaction between sending and receiving countries or regions. However, most students of multiregional demography are still shown the beauty of stationary multiregional models with fixed transition probabilities. One reason for maintaining the constancy assumption is that it allows for concise mathematical analysis with attractive solutions. Like Rogers' "requiem," Plane's call for ending the unrealistic assumption of fixed transition rates has rarely been echoed in practice.

4.5   A way forward

So far, demographic projections that include separate assumptions for immigration and emigration are rare.[28] This is, however, the way forward. At national level more accurate flow data can provide the basis for such a change. At global level the sustained data collection efforts of the Global Migration Database, initiated by the United Nations Population Division (2014), and maintained and extended through collaboration with the United Nations Statistics Division and the World Bank (Özden et al. 2011), provided sufficient empirical data for the groundbreaking translation of available stock data into bilateral flow estimates (Abel and Cohen 2019, 2022; Abel 2022)[29]. Incorporating these data into a population projection model allows for population forecasts that account for all possible migration flows in the world. This can then be broken down to regional and national levels as demonstrated in this paper. Population projections that account for immigration and emigration separately, like the one presented in this paper, reduce at least all uncertainties linked to the use of net migration. Such projections have a stronger empirical basis. And they allow for specifications in the assumptions which can address other areas of uncertainty by quantifying scenarios capturing alternative futures and/or the effects of anticipated geopolitical, labour demand and supply or migration policy changes.

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[27] For the European Union see: https://espas.eu/horizon.html

[28] Why international migration should play a role in population projections is argued in Buettner and Muenz (2016). For attempts to incorporate bilateral migration flow estimates see: Rikani and Schewe (2021); Buettner (2023).

[29] See also Azose and Raftery (2019).

5   Annex

This Annex lists more detailed results of the projection exercise, namely the flow matrices for certain regions. For more detailed methodological information and numerical results see the technical paper published in parallel as supporting information (Buettner, Muenz 2024 The Impact of Migration on Future Population Change. Technical Information. KNOMAD Working Papers no. 60).

5.1   Data Base

The estimation of migration flow data is limited by the available raw data of migrant stock, collected by national censuses and surveys (United Nations 2020). The data were further limited by changes in the composition nation states by separation or unification of certain countries. Abel and Cohen transformed the available stock data to bilateral migration flows, which provided the basis for our migration projections. Together, that resulted in a coverage of 98.8% or 194 countries out of 237 countries in the 2022 Revision of World Population Prospects (WPP). In terms of total population and stock of migrants this amounts to almost universal coverage. There are, however, a few larger countries which are not included because territorial splits during the analysed period (Serbia/Kosovo; Sudan/South Sudan) or for political reasons (Taiwan).

Table 22: Population coverage

Topic	Total	Included	Not included
Number of countries	237	194	43
Population	7,941,658,316	7,849,674,346	91,983,970
Proportion	100.0%	98.8%	1.2%
Largest country	1,425,925,386	1,425,925,386	46,261,499
Smallest country	508	44,446	508

The largest country that could not be included in this exercise is the former Sudan which, in 2011, split into two countries (Sudan/South Sudan), followed by Taiwan which is not recognized by the UN and most UN member states as a self-governed territory, but listed in official statistics as "Province of China" as well as Serbia (split into Serbia/Kosovo in 2008; see Table 23).

Table 23: Largest populations not covered, 2022

Country	Total population 1.1.2022
Sudan	46,261,499
China, Taiwan Province of China	23,877,791
South Sudan	10,829,532
Serbia	7,261,591
Kosovo (under UNSC res. 1244)	1,657,760

5.2   Migration Flows by Origin and Destination

The data listed combining estimates (1990-2019) and projections (2020-2049) for the World Bank Regions.

Table 24: World Bank Regions, 2020-2024

Destinations	Origins						
	East Asia & Pacific	Europe & Central Asia	Latin America & Caribbean	Middle East & North Africa	North America	South Asia	Sub-Saharan Africa
East Asia & Pacific	**6,025,847**	1,090,778	130,204	1,342,033	1,266,593	2,210,486	295,863
Europe & Central Asia	1,534,611	**21,277,377**	1,444,059	4,034,768	1,651,003	3,351,703	1,907,360
Latin America & Caribbean	163,911	1,040,605	**8,256,533**	57,879	3,113,560	57,922	18,603
Middle East & North Africa	571,938	1,568,627	11,018	**3,631,331**	292,363	6,134,238	138,648
North America	1,711,702	1,984,013	4,267,173	1,960,102	**360,837**	3,815,197	1,279,448
South Asia	974,605	307,967	1,573	2,503,925	414,063	**2,525,966**	15,030
Sub-Saharan Africa	42,459	506,619	1,508	236,942	226,745	35,400	**5,312,695**

Table 25: World Bank Regions, 2025-2029

Destinations	Origins						
	East Asia & Pacific	Europe & Central Asia	Latin America & Caribbean	Middle East & North Africa	North America	South Asia	Sub-Saharan Africa
East Asia & Pacific	**6,071,649**	1,078,432	128,285	1,397,141	1,233,570	2,275,385	315,198
Europe & Central Asia	1,606,980	**21,712,321**	1,527,950	4,258,383	1,685,771	3,452,575	1,941,491
Latin America & Caribbean	172,274	1,055,311	**8,891,003**	61,933	3,148,390	63,105	19,112
Middle East & North Africa	595,481	1,634,254	9,813	**3,727,625**	300,546	6,210,731	143,382
North America	1,673,727	2,041,192	4,254,333	2,057,473	**362,750**	3,858,788	1,294,042
South Asia	1,037,338	310,291	1,532	2,556,110	421,483	**2,527,867**	14,086
Sub-Saharan Africa	41,405	504,392	1,429	249,670	232,277	35,251	**5,291,639**

Table 26: World Bank Regions, 2030-2034

Destinations	Origins						
	East Asia & Pacific	Europe & Central Asia	Latin America & Caribbean	Middle East & North Africa	North America	South Asia	Sub-Saharan Africa
East Asia & Pacific	**6,093,328**	1,074,845	127,782	1,415,255	1,228,735	2,298,580	321,699
Europe & Central Asia	1,630,846	**21,863,665**	1,555,961	4,338,295	1,697,207	3,488,581	1,954,705
Latin America & Caribbean	175,006	1,061,061	**9,102,484**	63,260	3,159,808	64,801	19,444
Middle East & North Africa	603,711	1,657,177	9,422	**3,766,262**	303,235	6,240,270	145,328
North America	1,664,543	2,060,421	4,252,856	2,090,079	**363,378**	3,873,075	1,303,086
South Asia	1,057,895	311,057	1,522	2,573,209	423,912	**2,528,514**	14,212
Sub-Saharan Africa	41,070	506,098	1,402	253,835	234,094	35,628	**5,291,398**

Table 27: World Bank Regions, 2035-2039

Destinations	Origins						
	East Asia & Pacific	Europe & Central Asia	Latin America & Caribbean	Middle East & North Africa	North America	South Asia	Sub-Saharan Africa
East Asia & Pacific	**6,103,638**	1,073,846	127,644	1,421,198	1,227,308	2,306,269	323,852
Europe & Central Asia	1,638,688	**21,915,035**	1,565,172	4,364,559	1,700,949	3,500,600	1,959,165
Latin America & Caribbean	175,905	1,062,964	**9,171,887**	63,694	3,163,541	65,356	19,577
Middle East & North Africa	606,547	1,664,680	9,289	**3,779,061**	304,122	6,253,057	145,949
North America	1,662,550	2,066,831	4,252,465	2,100,903	**363,581**	3,877,756	1,306,098
South Asia	1,064,633	311,313	1,517	2,578,820	424,709	**2,528,720**	14,248
Sub-Saharan Africa	40,960	506,765	1,394	255,209	234,681	35,759	**5,293,565**

Table 28: World Bank Regions, 2040-2044

Destinations	Origins						
	East Asia & Pacific	Europe & Central Asia	Latin America & Caribbean	Middle East & North Africa	North America	South Asia	Sub-Saharan Africa
East Asia & Pacific	**6,107,043**	1,073,548	127,590	1,423,152	1,226,844	2,308,786	324,567
Europe & Central Asia	1,641,301	**21,932,012**	1,568,185	4,373,224	1,702,173	3,504,550	1,960,643
Latin America & Caribbean	176,211	1,063,606	**9,194,632**	63,835	3,164,777	65,540	19,618
Middle East & North Africa	607,487	1,667,170	9,244	**3,783,243**	304,419	6,257,490	146,161
North America	1,661,900	2,068,923	4,252,347	2,104,459	**363,649**	3,879,289	1,307,083
South Asia	1,066,839	311,398	1,515	2,580,651	424,972	**2,528,797**	14,265
Sub-Saharan Africa	40,933	507,010	1,390	255,667	234,889	35,798	**5,294,805**

Table 29: World Bank Regions, 2045-2049

Destinations	Origins						
	East Asia & Pacific	Europe & Central Asia	Latin America & Caribbean	Middle East & North Africa	North America	South Asia	Sub-Saharan Africa
East Asia & Pacific	**6,108,124**	1,073,434	127,574	1,423,792	1,226,691	2,309,622	324,793
Europe & Central Asia	1,642,140	**21,937,561**	1,569,180	4,376,040	1,702,585	3,505,872	1,961,146
Latin America & Caribbean	176,301	1,063,799	**9,202,091**	63,887	3,165,175	65,598	19,635
Middle East & North Africa	607,794	1,667,986	9,233	**3,784,623**	304,513	6,258,955	146,243
North America	1,661,724	2,069,618	4,252,302	2,105,623	**363,671**	3,879,795	1,307,404
South Asia	1,067,567	311,419	1,515	2,581,256	425,056	**2,528,816**	14,270
Sub-Saharan Africa	40,912	507,060	1,390	255,805	234,953	35,815	**5,295,188**

5.3 Abbreviations

Table 30: Income groups

Symbol	Group	Countries
LIC	Low income	26
LMC	Lower middle	55
UMC	Upper middle	46
HIC	High income	61

Table 31: Geographic areas

Symbol	Group	Countries
EAS	East Asia &	31
ECS	Europe &	46
LCN	Latin America	34
MEA	Middle East &	21
NAC	North	2
SAS	South Asia	8
SSF	Sub-Saharan	46

Table 32: Miscellaneous abbreviations

Symbol	Group	Comments
EU27	European Union as of February 1, 2020	= after Brexit
EFTA	The European Free Trade Association	(CH, ISL, LI, NOR)
WPP	World Population Prospects	
AC	Guy Abel, Joel Cohen	

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