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Migration Projections : Baseline Profiles, Corridors

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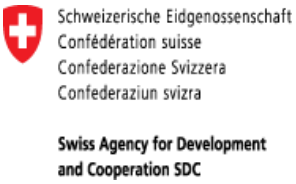

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*Migration Projections: Baseline Profiles, Corridors**

Thomas Buettner†

Abstract

This paper ventures into a challenging field of study. Like migration estimates, migration projections are often a stepchild of demographic interest. One reason for this is the dearth of reliable and sufficiently complete statistical registration. On a global level, net migration has been used to have at least migration's overall impact covered. This paper endeavours to put gross migration, that is the bilateral flows of people between countries, in the toolbox of demographers. The challenges for this are formidable. Because the original flow data are available for about 50 countries only, and because the aim is at the global level, the paper utilized recent estimates of bilateral migration flows that were derived from available foreign born or foreign citizenship populations. A comparison between official emigration and immigration statistics with annualized migration estimates showed reasonable accordance, if not for the level and fluctuations but for the apparent trend for several countries. Like all projection exercises, migration projections begin with the formulation of assumptions. The paper presents demographic baseline profiles for 15 countries, including migration flows, for the discussion of such projection assumptions. Finally, the paper presents some results of a projection exercise of total migration flows between 194 countries for which relevant data could be gathered and prepared. The presentation of results was organized by focusing on 29 migration corridors identified in a previous paper. The choice of the projection methodology was guided by the rough migration estimates that can only be seen as a starting point for further refinement. The migration flow projections are discussed in some detail for the most prominent migration between the United States, Mexico, El Salvador, and Guatemala (Central America – Norther America, Corridor 1). The paper concludes that, despite the poor data availability, the large number of countries, and the suggested move towards a single-year data format, bilateral migration flow projections are feasible.

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1 Introduction

This paper is a continuation of work on international migration estimates and projections under the KNOMAD[1] umbrella. The special focus of this work is the formal and practical inclusion of migration flows for those countries lacking data of immigration and emigration. Results would be certainly useful for demographers, development economist and other social scientist. This is not to say that international migration was neglected in the past. On the contrary, much effort was invested in analyzing, explaining, and managing international migration between countries, while data limitations, especially regarding flow statistics, limited the efforts. Only in developed countries is it possible to address international migration (also) as flow of people. This limited the coverage to about 50 countries in the world with usable migration statistics (Buettner 2022). Less developed countries were left outside these efforts, albeit some limited insight may be obtained by also exploring immigration from and emigration to developing countries as recorded in developed countries. Consequently, researchers utilized migrant stocks as a proxy of lifetime migration. Due to the dearth of statistical migration flow data researchers began utilizing migrant stocks as a proxy of lifetime migration.

Based on a comparative analysis of migration projections by major international organizations and groups (Buettner and Muenz 2016), alternative methodology based on migration flows was proposed (Buettner and Muenz 2018b, 2018a). Expanding the scope of migration drivers, the migration transition or *migration hump* hypothesis was analyzed and a formalism for inclusion into migration projection suggested (Buettner and Muenz 2020). A notable investigation into the *migration hump* hypothesis was published by (Rikani and Schewe 2021). There are also numerous attempts to expand the sources of migration related data by exploring alternative sources like social media and internet-based communication (see (Böhme, Gröger, and Stöhr 2020).)

This paper continues the exploration of useful migration projection methodology by focusing on migration corridors. It also aims at solutions that can be applied globally to all countries of the world, following the example of the United Nations World Population Prospects. Albeit the prevailing scarcity of genuine information on migration flows, it is suggested, strongly, to elevate migration analysis, estimation, and projection to a shorter unit of analysis, e.g., single years. For many countries in the developing world, population projections and robust population statistics are in a five-year age format, requiring five-year projection format[2].

Putting the scarcity and inadequacy of existing statistical data on migration flows aside for a moment, annual data and - in extension - projections of migration flows in an annual format would clearly be preferable. There are valid reasons for such a suggestion: Migration can be a very volatile process, reacting to sudden changes in countries of origin and destination. Contributing ng to the erratic or unstable behavior of migration flows is the multi-faceted composition of migratory movements. Some, like labour migration or ordinary movements are compounded with sudden events like refugee movements.

[1] Global Knowledge Partnership on Migration and Development (KNOMAD)

[2] The United Nation's Population Division is currently investing much effort into transforming their flagship output - the World Population Prospects - into a single year format.

When using a larger (and more convenient) time interval of, say, five years, much of the variable behavior of migration flows is collapsed into that five-year average. Spikes and drops virtually disappear. Migration data thus lose much explanatory and analytical potential.

2 Data and Methodology

2.1 Data

Migration data availability is a continuing challenge, despite efforts on many levels and institutions. The global data landscape is dominated by migration stock data and a serious scarcity of valid flow data. Statistics on immigration are available for less than 50 countries, or about one out of five globally. Emigration data are even less abundant and often less reliable. Studies have shown that migration data are deficient even for developed countries. Rarer still are data on demographic characteristics.

This is in stark contrast of the fact that the analysis and projection of international migration is necessarily global. Migrants today have the potential to select almost any country as destination, immigration controls notwithstanding. However, certain countries have emerged as main sending countries, and a select number of countries as receiving countries.

This study focuses on international migration flows, both recorded by statistical offices or estimated using models. The main data are from two sources:

- All demographic data are compiled from the comprehensive 2019 Revision of "World Population Prospects" (United Nations 2019). The data are provided for a total of 235 countries or areas, covering the estimation period 1950 to 2020, and the projection period from 2020 to 2100. Out of the 235 countries or areas, 194 are included in the database for this project. Because the bilateral migration flow estimates had 194 countries covered, 41 mostly smaller countries or areas (0.84% of the world population in 2020) were not included[3].
- Migration flow estimates for most countries of the world have become available by the pioneering work of Abel (Abel, 2009, 2017) and by Azose and Raftery, (Azose & Raftery, 2019) who introduced important improvements to the estimation methodology by employing a pseudo-Bayesian model that allowed for the consideration of return and transit migration between pairs of countries. The migration flow estimates for 194 countries of the world are from Abel and Cohen (2019; Abel 2021). The Abel-Cohen (AC) paper explored the performance of six stock-to-flow methods, among them the Azose and Raftery method[4] , which is used in this paper throughout. Abel and Cohen based their estimation on the 2019 Revision of the UN's Word Population Prospects (United Nations 2019b) and the 2020 Migrant Stocks dataset (United Nations 2019a).

In addition, migration flow data collected by EUROSTAT and OECD have been retrieved and incorporated into the database. As with the UN's data, the formats have been harmonized in respect to file format (a

[3] Some larger countries like Sudan and the newly independent South Sudan or Taiwan were missing in bilateral migration flow database due missing and consistent population stock data.
[4] Originally labelled *da_pb_closed* in the AC dataset

simple and common flat-file format, known as comma-separated value file), country, age and time references, and indicator names.

2.2 Methodology

Migration flow estimates (G. Abel 2021) are available for 5-year periods beginning in 1990 and ending in 2020 (6 data points). For comparison reasons and testing simple forecasting methods, the quinquennial migration flow estimates were interpolated with a standard demographic osculatory interpolation method (Siegel and Swanson 2004, 727).

The draft document was developed with an authoring system in RStudio (RStudio Team 2022) (RStudio Team, 2022), a graphical user interface for the programming language R (R Core Team 2021) Data retrieval and processing software was developed by the author. In addition, several open-source software components, all in the programming language R were employed: the table processing package *data.table* (Dowle & Srinivasan, 2021) the *forecasting* package *forecast* (Hyndman & Khandakar, 2008), the graphics package *ggplot2* (Wickham, 2016), and the package *officer* (Gohel & Ross, 2021) for rendering output to MS Word documents.

Forecasting migration flows for all counties of the world is confronted with challenges. First, mentioned previously, the lack of original and genuine statistical data for most countries. Second, the existing migration flow data do not necessarily employ consistent definitions of what constitutes a migrant, and what not. Third, the actual migration flows are often not following a clear trend, instead, they reflect changes in the political setting of countries of origin and countries of destination. They reflect major shocks such as civil strife, internal and international war, natural disaster and, increasingly, the effects of global warming. Migration flows are also strongly influenced by economic opportunities and policy settings.

The last decades have seen incremental but steady progress in the availability of population stock data (as base for estimating migration flows) and, as mentioned earlier, methodology. By relying on data from censuses, population registers or surveys, the estimates were forced to use a five-year reference period, that is, they represented the average (estimated) flows between years five years apart.

The next goal is to prepare bilateral migration flow projections for all countries of the world using the interpolated annual migration flow data. What would be an optimal projection methodology? Clearly, the projection methodology must be appropriate for the underlying data. This paper utilizes established time-series forecasting models. This is far apart from much more sophisticated models used and still further developed by researchers focusing on, say, migration flows that affect the European Union (see, for the latest example, the comprehensive QuantMig project https://www.quantmig.eu/).)

The R-language package *forecast* for time series forecasting offers some robust and well—established methods for estimating, forecasting and evaluation of time series. Two of the methods available were considered: exponential smoothing (ETS[5]) and autoregressive integrated moving average (ARIMA) and their different parameterizations. In this paper, results prepared by using the ETS model are presented.

[5] **E**xponen**T**ial **S**moothing (ETS)

For simplicity and transparency reasons, special data transformation that ensure positivity of results (logit or Box-Cox-transformation) were not used. They might be re-considered at a later stage.

The FORECAST.ETS function calculates an optimal model for predicting future value based on existing (historical) values: "… exponential smoothing methods are weighted averages of past observations, with the weights decaying exponentially as the observations get older. In other words, the more recent the observation the higher the associated weight." (Hyndman and Athanasopoulos 2021). The ETS forecasting package is based on 30 different exponential smoothing methods. Hence, the projections prepared for this exercise all use a variety of exponential forecasting models, selected by the ETS function as optimal. The identification of the model used for each forecast is coded as a combination as three letters (see (Hyndman and Khandakar 2008; Hyndman and Athanasopoulos 2021). They are shown at the bottom of charts. The meaning of the coded smoothing methods can be seen in the Appendix 8.4.

The ETS forecasting model was applied to the interpolated AC data (G. Abel and Cohen 2019; G. Abel 2021)(Abel and Cohen 2019; Abel 2021), both for absolute and relative figures. Relative flow measures, e.g., crude migration rates, turned out to be preferable, as they allow for easier comparison and are more stable when forecasted. As migration flow data in public discourse are absolute figures, projections of relative measures would need to be integrated into a population projection to translate relative into absolute figures.

Flow data are relevant for two entities - the sending entity, and the receiving entity (here: countries). What may be seen as self-evident has implications for measurement, understanding, and, finally, projections. This may be illustrated with a simple example: The AC dataset shows 2,657,149 migrants from Mexico to the United States from 1990 to 1995. The number remains the same when seen from Mexico as emigration and for the US as immigration. Measured as occurrence/exposure rates, the view changes. The crude emigration rate for Mexico for the five years 1990 to 1995 is 6.05 per one thousand population, while the crude immigration rate from Mexico into the US amounts to 2.06 per one thousand population. The same absolute number of migrants is associated with significantly different relative migration measures.

3 Comparison of Flow Estimates with Official Statistics

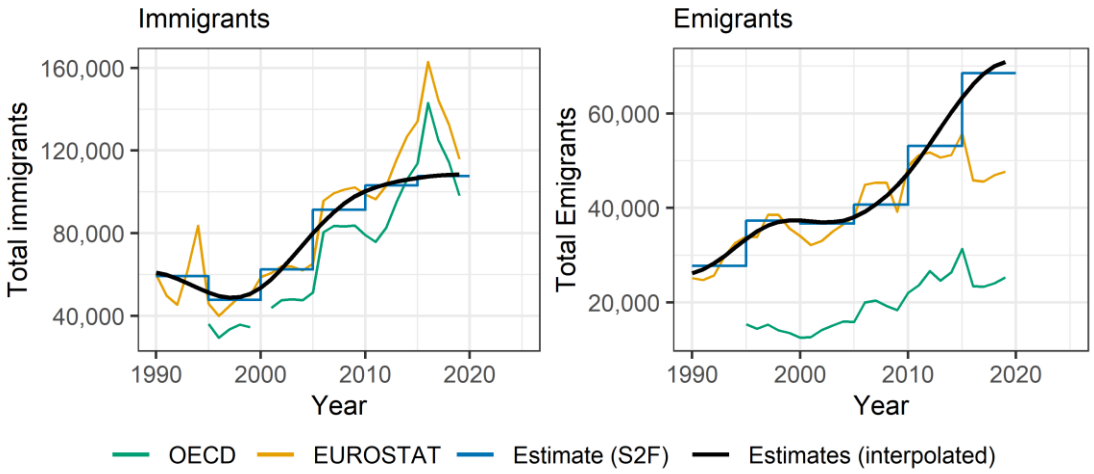
In a brief digression from the main topic of this paper, the latest migration flow estimates were compared to select time series of official statistics, namely from EUROSTAT, the main statistical authority of the European Union, and OECD. The data collected by EUROSTAT are submissions of the statistical offices of the 27 member countries, plus some affiliated countries. The OECD data are submitted by designated correspondents from several countries (see Buettner, 2022).

A comparison of the (interpolated) migration flow data with official statistics may help understanding the deficiencies of both official and estimated flow data[6].

[6] To keep the comparison small, just total immigration and emigration data are compared. They do not show the bilateral dimension, that is the flow between distinct countries.

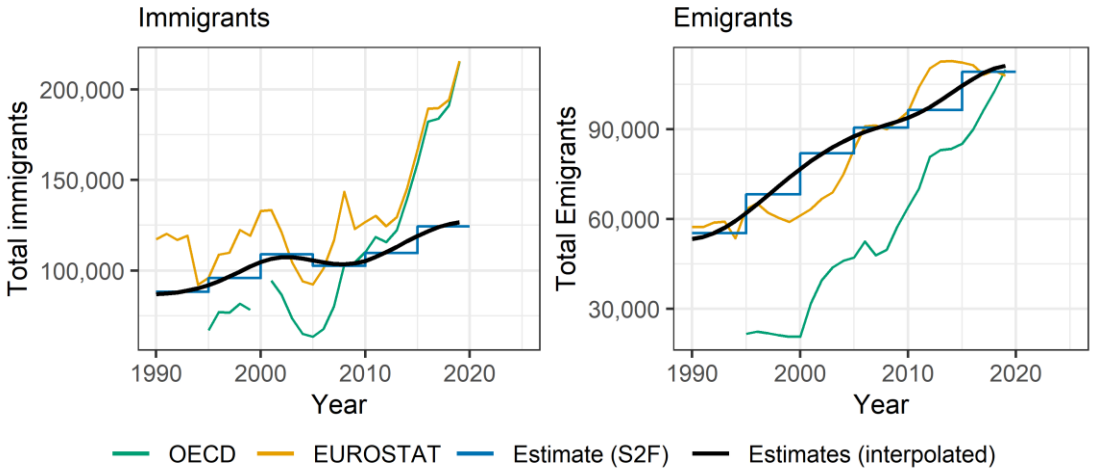
The charts showing data for Sweden the Netherlands, Portugal, Germany, and the United Kingdom are comparing EUROSTAT and OECD statistics on Immigration and Emigration with the estimates used in this paper. The estimates are presented in two formats, first in the original five-year average, and second as an interpolated time series. The comparison of only four selected countries does not allow for a general appraisal of the quality and validity of the flow estimates used in this paper. A comparison should be aware that the AC data have been census or register data that may not fully reflect all types of the migrant population. Furthermore, The AC data have been adjusted against the net migration data produced by the United Nation data. Net-migration is a residual measure that may reflect, instead of the balance of emigration and immigration, measurement errors and registration procedures attributable to births, deaths, and population. Finally, it should be noted that the data collected by EUROSTAT and OECD are not fully compatible due to different migration definition.

Figure 1: Sweden: Immigrants and emigrants, by source, 1990-2020



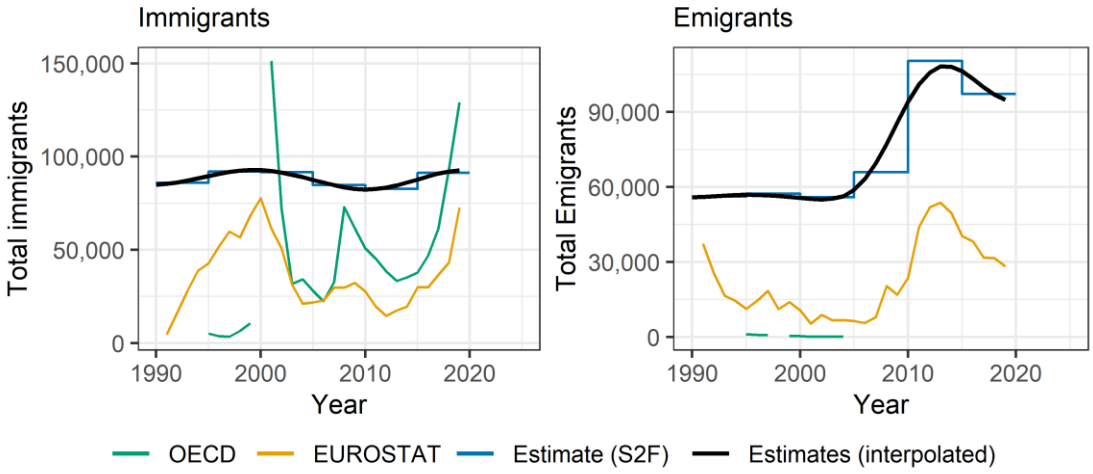
We start with Sweden comparing official statistics with estimated flow data, the latter both as originally formatted in quinquennial periods, and annualized estimates. It is no surprise that the EUROSTAT and OECD data for Sweden seem to agree reasonably well with the estimated flow data. The agreement appears strongest for immigrants. Estimated emigrant data resemble well the EUROSTAT statistics, while OECD data, listing only foreigners as migrants, are not compatible for emigrants. If the relatively good accordance between estimates and official statistics is no surprise because of the very effective Swedish statistics system, neither should be that the sharp fluctuations shown for the official statistics are not reflected in the estimated (interpolated) flow data.

Figure 2: Netherlands: Immigrants and emigrants, by source, 1990-2020



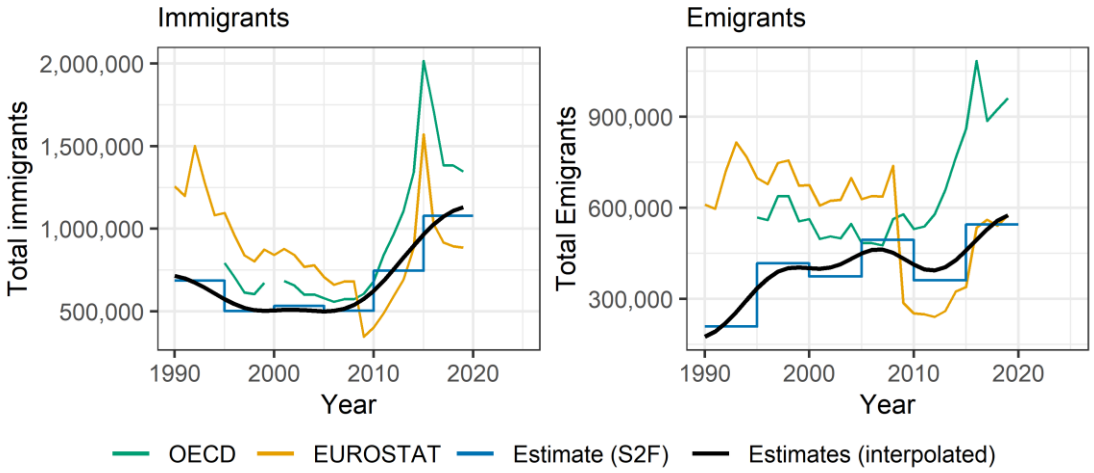
For the Netherlands, it looks quite different. While the overall trend is visible in the estimated figures, it misses dramatically the significant increase of immigrants after 2014. Emigrants are captured quite well by the AC estimates. One reason for missing the upturn of immigrants may be associated with the underlying stock estimates, which are for the year 2020 themselves extrapolations, on most occasions.

Figure 3: Portugal: Immigrants and emigrants, by source, 1990-2020



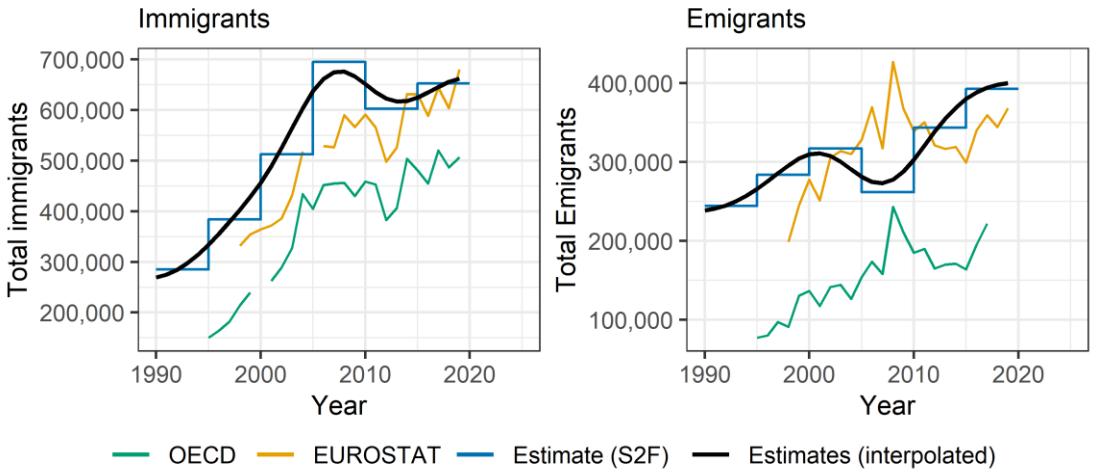
The charts comparing statistics and AC estimates for Portugal do not allow easy explanation. The statistics collected by EUROSTAT and OECD exhibit many fluctuations, for immigrants, while for emigrants, OECD data are spurious, but EUROSTAT data and the AC data series at least seem to have similar shapes.

Figure 4: Germany: Immigrants and emigrants, by source, 1990-2020



The data for Germany also show similarities and dissimilarities between official statistics for immigrants and emigrants. The AC data resemble EUROSTAT statistics for immigrants reasonably well, at least the overall trend. For immigrants, the data disagree more.

Figure 5: United Kingdom: Immigrants and emigrants, by source, 1990-2020



The data for the United Kingdom show a huge level of movements, both for immigration and emigration. As with the countries discussed before, the estimated flows are closest to the recorded movements from EUROSTAT, while the OECD statistics are significantly lower, but with similar trend.

The comparisons made are for countries with very good or developed statistical systems, albeit using (slightly) different definitions and procedures. Analysis and projection of migration flows in the remainder of the paper are addressing international migration flows of or between countries lacking reliable statistical systems. Hence, meaningful comparisons with actual recorded data cannot be drawn. Still, the above comparisons give measured hope.

4 Baseline Profiles

As a preparatory task for formulating assumptions for planned population projections that incorporate migration in terms of bilateral flows, this paper provides also baseline profiles for a set of select countries. Basic demographic indicators for 15 select countries are presented in compact form in Annex 8.1. The country profiles list characteristic demographic indicators, such as the total population, median age of the population, children per woman or total fertility), life expectancy for both sexes combined, natural change, that is the difference between births and deaths, and total net migration. In addition, and for affording a more complete picture, estimates of total emigration and immigration are presented. The latter two indicators are usually not available for the countries listed in Annex 1. It is important to acknowledge that these estimates are the result of a multi-layered process of adjustments and assumptions. They have been brought in line with the UN's net migration estimates, which are themselves not observed but are a residual figure that may be close to the actual value. Finally, the country profiles also list a summary measure about the efficiency of migratory movements, or Migration Effectiveness. This indicator is common in studies of subnational migration (United Nations 1970) but may also be a valuable measure for individual countries. Migration effectiveness measures net migration as a proportion of gross migration turnover for any territorial unit (Stillwell et al. 2000). Or, simpler, it is the ratio of net to gross migration. The most effective migration would be one that is only in one direction, e.g., just emigration or immigration. Hence, an effectiveness ratio of 100 indicates unidirectional migration, either immigration or, with negative sign, emigration.

As a somewhat arbitrary selection, the 15 countries selected have still commonalities. **Table 1** shows cumulated measures of basic demographic measures for the years 1990 - 2020, spanning the whole estimation period. Except for Ethiopia, all other countries experienced negative net migration, e.g., the number of emigrants exceeds the numbers of immigration, sometimes by a wide margin. Consequently, for the 14 countries with negative net migration over the 30-year period their migration efficiency is negative. The highest absolute migration efficiency, e.g., the dominance of one directional flow over the opposite is shown for Myanmar (-69), the Philippines (-50) and Bangladesh (-49).

In the selected 15 countries, Ukraine stands out. It had on average emigration and immigration numbers virtually equal (-1).

The 15 countries were subject to relatively high international mobility, with 27 million people emigrating form India, almost 16 million from Bangladesh and or Mexico. The largest inflows by far had India with about 17 million people. **Table 1** also shows each country's percentage on overall mobility of the 194 countries included. India, the second-largest country of the world, has the highest share on global mobility, with 5.8% of overall emigration movements, and 3.5% of global immigration flows. Bangladesh and China, also very populous countries, exhibit relatively large shares, too.

Table 1: Baseline Profiles Summary Indicators 1990-2020

Country	Emigration	Immigration	Net migration	Efficiency	Share of global emigration	Share of global immigration
Bangladesh	15,829,908	5,413,321	-10,416,587	-49	3.3%	1.1%
China	14,256,594	6,212,249	-8,044,345	-39	3.0%	1.3%
Egypt	3,577,963	2,005,515	-1,572,448	-28	0.8%	0.4%
Ethiopia	1,403,248	1,866,182	462,934	14	0.3%	0.4%
India	27,327,879	16,690,875	-10,637,004	-24	5.8%	3.5%
Kazakhstan	7,900,585	5,280,279	-2,620,306	-20	1.7%	1.1%
Mali	2,166,863	1,183,944	-982,919	-29	0.5%	0.2%
Mexico	15,629,637	7,837,549	-7,792,088	-33	3.3%	1.7%
Morocco	4,479,421	1,640,155	-2,839,266	-46	0.9%	0.3%
Myanmar	6,281,875	1,147,016	-5,134,859	-69	1.3%	0.2%
Nigeria	3,153,838	1,944,763	-1,209,075	-24	0.7%	0.4%
Pakistan	12,235,331	8,468,125	-3,767,206	-18	2.6%	1.8%
Philippines	8,383,900	2,784,585	-5,599,315	-50	1.8%	0.6%
Senegal	1,628,947	591,494	-1,037,453	-47	0.3%	0.1%
Ukraine	8,873,427	8,776,606	-96,821	-1	1.9%	1.9%
Total	**133,129,416**	**71,842,658**	**-61,286,758**	**-30**	**28.1%**	**15.1%**

Notes Calculations for 194 countries as covered in this paper

Source Abel 2021, authors calculations

A more detailed presentation of major indicators is available in Annex 7.1

5 Spatial Organization of Migration Flows

International migration is not completely arbitrary. It often follows established networks and, if circumstances change, gravitates to new opportunities. Migration network or migration corridor are an important part of the spatial organization of human mobility. They provide an analytical unit, established or emerging, that can guide analysis, and, it is hoped, projecting of migration flows. Migration corridors may also reduce the complexities of analyzing and projection bilateral migration flows, here eventually for 1994 countries.

5.1 Migration Corridors

In the International Migration Organization's (IOM) flagship publication "World Migration Report," migration corridors are defined broadly based on migrants stock data (lifetime migration):
"Corridors represent an accumulation of migratory movements over time and provide a snapshot of how migration patterns have evolved into significant foreign-born populations in specific destination countries" (IOM 2019, chap. 3).

This paper is instead focusing on migration flows. Migration flow networks can be identified using different approaches and methodologies ((G. J. Abel et al. 2021; Fagiolo and Mastrorillo 2013). Here we explores 29 migration corridors identified in a recent KNOMAD paper by Köppen et al. (Köppen,

Buettner, and Muenz 2022), using Jenks natural breaks classification method (George F. Jenks 1963; G. F. Jenks 1977), with 5 classes.[7]

Migration corridors are shaping the structure of the global migration network and because they appear to be relatively stable, are expected to be more relevant for modeling future trends. There has been a relatively solid body of research on migration corridors, but mainly limited to about 50 countries with reliable statistical systems (Buettner 2022). Those countries are members of OECD or are covered by EUROSTAT. Developing countries are hereby also covered, but only as recorded as immigrants from a developing country or as destination for emigrants. Migratory movements between developing countries are largely uncovered, notably in Africa.

According to a recent KNOMAD working paper (Köppen, Buettner, and Muenz 2022), the most prominent destination countries in forming migration corridors are the United States of America, India, the Russian Federation, the Gulf States (especially the United Arab Emirates and Saudi Arabia), Germany, Mexico, Bangladesh, Ukraine and Kazakhstan (the latter often connected to migration - return migration relations). The space of former Soviet Union shows vivid and strong migration corridors oriented to and from the Russian Federation.

While the relative stability of migration corridors may count as an advantage, they are still subject to "shocks" in the form of unexpected refugee movements (see the 2015 European refugee crisis), regional or global movement barriers due to policy changes or, as the case of the COVID19 showed, by a global health emergency. Other such shock or sudden deviations from long-term trends are observed from global climate change, or civil strife and military conflicts.

The 29 identified migration corridors are composed of a relatively large number of individual countries. Altogether, there are 72 different countries included in the migration corridors. Because 15 countries are considered several times, the total sum of countries rise to 96. All corridors have been analyzed and projected, but the limited space available calls for limiting the discussion to just one corridor. Here, summary results for the 29 corridors are briefly discussed, followed by a more in depth presentation of the first migration corridor, entitled "Central America - Northern America," or Corridor 1.

5.1.1 Summary Results for Migration Corridors

To still allow for glance at some summary results, tabulations of the total inside migration, the total other emigration and immigration, both in absolute and relative figures, are presented. The figures are separately shown for the period 1990-2020 (past estimates) and 2020-2035 (projections).

Table 2 shows, in its column entitled "Internal" the total migratory movement within the corridor and for the shown period. The internal data are not shown separately for immigration and emigration as corridors are closed systems, that is emigration and immigration are, for the corridor, equal. This is not the case for the external migration, here all immigrants to and emigrants from the corridor, excluding the internal migration. Summing internal migration and external emigration is the total emigration associated with the corridor, while the adding external immigration and internal migration is the total immigration associated with the corridor.

[7] Jenks method seeks to reduce the variance within classes and maximize the variance between classes

Table 2: Summary of corridor migration estimates and projections (millions)

Index	Corridor	Internal	Emigration, external	Immigration, external	Internal	Emigration, external	Immigration, external
		1990-2020			2020-2035		
1	Central America - Northern America	26.9	24.1	47.2	12.1	15.1	30.5
2	South America - Northern America	1.6	33.9	64.9	.3	20.9	42.6
3	South America	3.2	6.1	1.9	13.8	15.6	3.0
4	Caribbean - Northern America	6.7	30.4	61.4	5.4	19.6	33.4
5	Northern America	2.1	35.3	75.3	1.0	22.5	43.0
6	Eastern Europe	13.5	12.4	24.1	6.8	7.4	8.8
7	Central Asia - Eastern Europe	15.6	13.5	19.9	7.5	7.2	7.2
8	Western Asia - Eastern Europe	3.1	16.1	25.0	.7	8.8	9.9
9	Southern Asia - Northern America	9.2	55.5	84.9	7.6	34.4	45.3
10	Southern Asia	28.4	43.5	14.2	9.1	34.3	15.6
11	Southern Asia - Western Asia	37.1	34.0	22.8	21.6	30.1	13.9
12	Western Asia	13.7	11.2	9.5	5.5	11.7	5.9
13	Eastern Asia - Northern America	11.6	43.0	75.6	5.5	29.6	44.4
14	South Eastern Asia - Northern America	10.6	39.7	71.3	5.6	23.8	42.4
15	South Eastern Asia	9.2	12.4	9.2	5.2	9.8	5.9
16	Eastern Asia	8.3	14.8	9.4	4.9	10.2	6.0
17	Western Asia - Europe	3.7	13.8	25.1	2.2	11.9	22.9
18	Southern Africa	3.5	2.7	1.8	1.9	1.5	1.0
19	South Eastern Asia - Western Asia	2.3	11.2	11.1	1.6	9.4	6.6
20	Europe - Eastern Europe	2.3	24.7	44.6	1.2	18.3	28.8
21	Northern America - Europe	5.2	47.2	95.7	3.7	33.4	64.0
22	Europe	6.5	21.1	30.1	7.4	17.0	24.7
23	Southern Asia - Europe	1.9	34.7	30.5	1.4	23.6	19.0
24	Northern Africa - Europe	6.8	13.4	17.9	3.7	8.1	10.5
25	Eastern Africa - Middle Africa	2.5	3.4	3.1	.2	1.4	1.5
26	Eastern Africa - Southern Africa	2.1	3.2	4.8	.8	2.1	2.5
27	Europe - Australia/New Zealand	2.2	12.0	22.7	1.2	9.1	16.1
28	Southern Asia - South Eastern Asia	1.2	18.2	10.6	1.2	11.6	8.4
29	Central Asia - Europe	1.6	18.3	24.0	.7	14.1	22.4

It will be interesting to express the relationship between internal and external migration for each corridor in relative terms, allowing for a better comparison between corridors. **Table 3** shows the ratio of internal migration to total emigration and total immigration. The measure expresses the level of dominance of migration within the corridor relative to the total migratory movement associated with the corridor.

Table 3: Proportion of internal migration on total, by corridor

Index	Corridor	Emigration	Immigration	Emigration	Immigration
		1990-2020		2020-2035	
1	Central America - Northern America	53%	36%	44%	28%
2	South America - Northern America	4%	2%	1%	1%
3	South America	34%	62%	47%	82%
4	Caribbean - Northern America	18%	10%	21%	14%
5	Northern America	6%	3%	4%	2%
6	Eastern Europe	52%	36%	48%	43%
7	Central Asia - Eastern Europe	54%	44%	51%	51%
8	Western Asia - Eastern Europe	16%	11%	7%	7%
9	Southern Asia - Northern America	14%	10%	18%	14%
10	Southern Asia	39%	67%	21%	37%
11	Southern Asia - Western Asia	52%	62%	42%	61%
12	Western Asia	55%	59%	32%	48%
13	Eastern Asia - Northern America	21%	13%	16%	11%
14	South Eastern Asia - Northern America	21%	13%	19%	12%
15	South Eastern Asia	43%	50%	35%	47%
16	Eastern Asia	36%	47%	33%	45%
17	Western Asia - Europe	21%	13%	16%	9%
18	Southern Africa	57%	66%	56%	65%
19	South Eastern Asia - Western Asia	17%	17%	15%	20%
20	Europe - Eastern Europe	9%	5%	6%	4%
21	Northern America - Europe	10%	5%	10%	5%
22	Europe	24%	18%	30%	23%
23	Southern Asia - Europe	5%	6%	5%	7%
24	Northern Africa - Europe	34%	28%	31%	26%
25	Eastern Africa - Middle Africa	43%	45%	15%	14%
26	Eastern Africa - Southern Africa	39%	31%	29%	25%
27	Europe - Australia/New Zealand	16%	9%	11%	7%
28	Southern Asia - South Eastern Asia	6%	10%	9%	12%
29	Central Asia - Europe	8%	6%	4%	3%

Internal migration, that is migration between a corridor's constituent member countries, is clearly dominating the overall migration trends in a few corridors, for example: Corridor 7 (Central Asia - Eastern Europe), Corridor 11 (Southern Asia - Western Asia), Corridor 18 (Southern Africa), and Corridor 3 (South America). There are also some migration corridors that are but a small part of the overall mobility associated with them: Corridor 2 (South America - Northern America), corridor 5 (Northern America), and corridor 29 (Central Asia - Europe).

5.1.2 Corridor 1: Central America - Northern America

This section discusses the results of migration flow projections by selecting the first migration corridor out of the 29 corridors identified. Such a stark limitation is, unfortunately called for to keep the size of this paper small and within limits. The limitation is also justified by the preliminary nature of this exercise. Still, the procedures to prepare all required data, to process projection methods and to prepare results for presentation were carried out for all 194 countries for which data were available. Projections were first calculated for migration flows between all countries, and the migration flows within the 29 corridors were selected from that pool of projections.

A change to a single year format, therefore, seems to be necessary and - as this paper aims to show - feasible. It allows better inclusion of short-duration events and has become technically possible due to ever growing computing power and computer memory. One important limiting factor remains: the profound lack of necessary data upon which the formulation of projection assumptions and the processing of the data is based.

Projecting migration flows for migration corridors yielded mixed results. For those corridors with a stable trend in the past, the exercise produced plausible trajectories. As was mentioned before, for some countries, projected Crude Migration Rates turned negative. Part of this problem seem to be a strong and sudden downward trend before the end of the migration period (that is before 2020). Also, bilateral migration streams with only very few migrants posed a problem, as erratic fluctuation seem to be common.

Starting with overall immigration and emigration from the four countries of Corridor 1, significant differences in the magnitude or volume of the overall flows are apparent. The United States is clearly dominating the migration flows, both for emigration and even more for immigration. Total emigration increased from 782 thousand emigrants in 1990 to about 1,3 million in 2019. The projection suggested a stabilization at that level. Mexico also has large emigration and immigration flows. In contrast with the United State, where immigration is exceeding immigration by far, Mexico's number of immigrants is much smaller compared to the number of people it receives.

5.1.2.1 Total Migrants

Migration corridors are part of the global migration system. Each member of corridor is likely to also have connections to countries outside the corridor. This can be expressed as the retention ratio, e.g., the ratio of total migration within the corridor to the overall migration flows associated with the countries of a corridor, presented below (section 5.2.3). We start with the overall migration flows for each country belonging to Corridor 1. **Figure 6** and **Figure 7** show plots of total immigration and emigration flows, from 1990 through 2035. The results for the projection period from 2020 to 2035 include point forecasts taken from the median of the forecasts (the blue line) and the confidence level for the prediction intervals at 89 and 95 per cent (shaded areas).

The results exhibit smooth continuation of past trends (from 1990-1019). Also noteworthy is propensity of the select exponential smoothing to relies strongest on the immediate past and considers less trends in the past. It may be surprising that uncertainty is growing very fast. For emigrants from Guatemala, Mexico and the United State, the 95 percent prediction interval approaches zero, implying no emigration. On the other hand, at 95 per cent uncertainty, emigration for those countries may also double. Very large prediction intervals, indeed.

Figure 6: Total Immigrants 1990-2035 by Country, Corridor 1

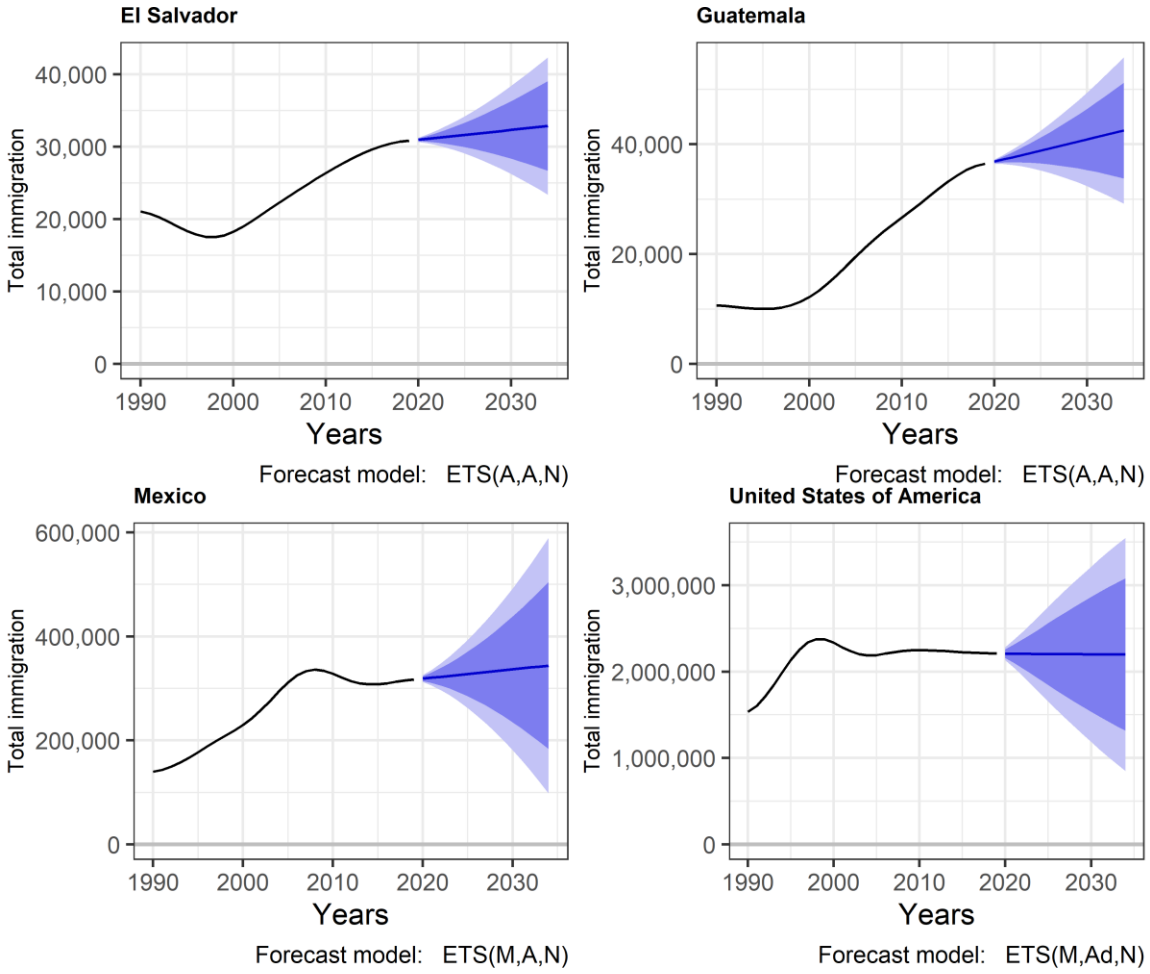
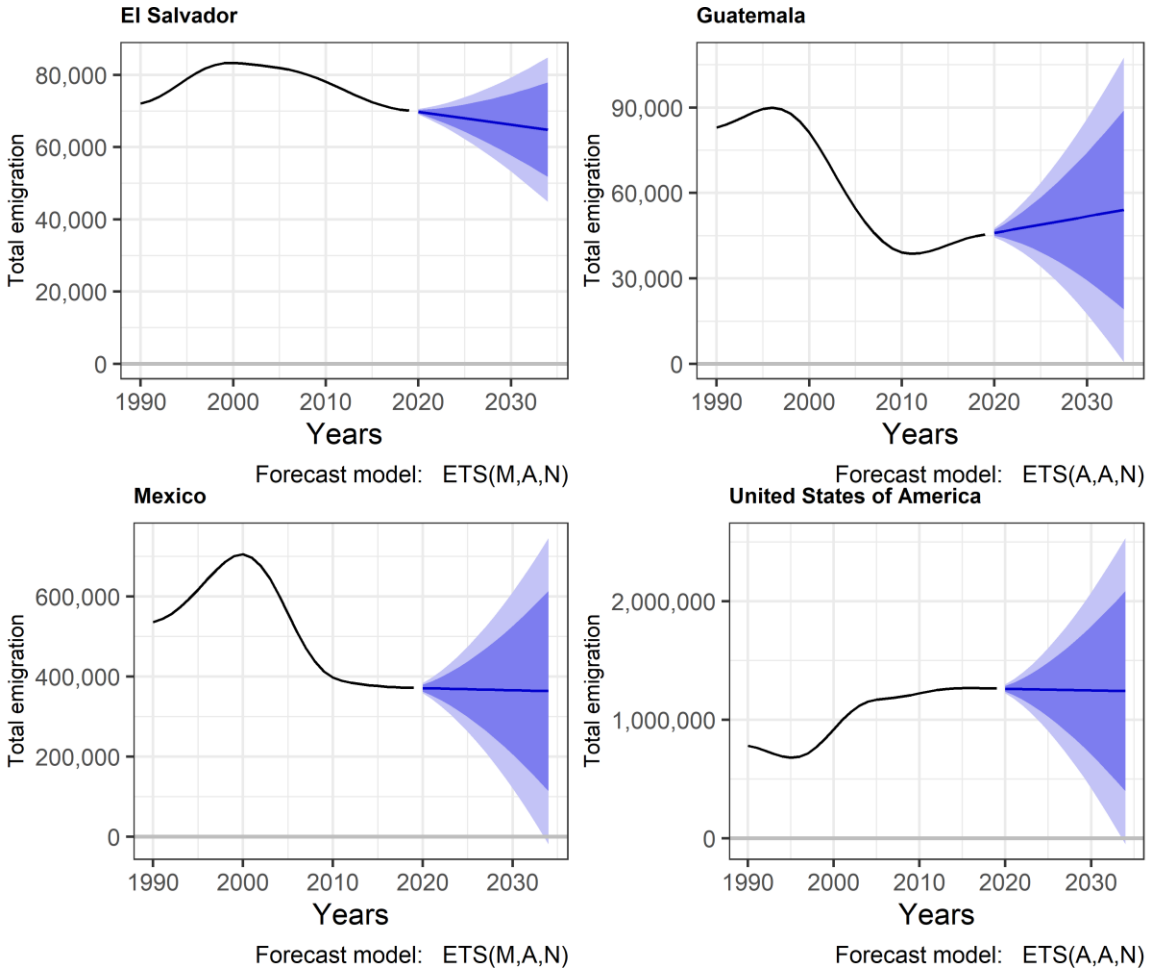


Figure 7: Total Emigrants 1990-2035 by Country, Corridor 1



5.1.2.2 Bilateral Migration Flows

Corridors are determined by the migration links they have among themselves. Their overall international mobility has just been briefly shown; now turning to the exchange of people within Corridor 1, first in absolute figures and as relative measure (**Table 4**). The proportion of migratory moves within a corridor relative to the overall amount of migration out of and in to that corridor is named retention ratio.

Table 4: Total migration within Corridor 1 and total, 1990-2035

Origins				
Variable	**GTM**	**MEX**	**SLV**	**USA**
	Emigration			
Corridor1	2,473,528	20,428,106	2,941,194	13,211,212
Total	2,674,105	21,519,143	3,406,914	51,230,690
Retention ratio	92%	95%	86%	26%
	Immigration			
Corridor1	1,095,964	11,742,490	1,054,595	25,888,654
Total	1,246,986	13,114,490	1,208,097	99,892,225
Retention ratio	88%	90%	87%	26%

ISO code	Country
GTM	Guatemala
MEX	Mexico
SLV	El Salvador
USA	United States of America
Source:	Authors calculations.

Migration Corridor 1 is characterized by a clear dichotomy: all Central American countries that are part of this corridor (Guatemala, Mexico, and El Salvador) have high retention ratios, that is, most of their immigration and emigration occurs within the corridor. On the other hand, the United States, despite their geographic proximity and close economic and labor force supply connections, has a much wider network of migratory connections beyond Corridor 1. The retention ratio is over the whole period at about a quarter (26%) of all migration events experienced by the United States. Still, Mexico remains the largest source of immigration for the United States.

Turning to total migration flows within Corridor 1, **Table 5** lists the quinquennial flows between the four constituent countries Guatemala, Mexico, El Salvador, and the United States for both the 1990-2020 estimation period and the 2020-2035 projection period. The table is in an origin-destination format, extending to 2035.

Table 5: Migration flows in Corridor Central America - Northern America (Corridor 1)

		Origins			
Destinations	**Periods**	**GTM**	**MEX**	**SLV**	**USA**
GTM	1990-1995	0	7,796	15,922	22,849
GTM	1995-2000	0	5,915	2,246	35,685
GTM	2000-2005	0	5,841	3,913	53,174
GTM	2005-2010	0	7,648	7,030	83,339
GTM	2010-2015	0	10,954	7,448	107,018
GTM	2015-2020	0	13,979	9,612	129,962
GTM	2020-2025	0	15,278	10,882	139,988
GTM	2025-2030	0	16,261	11,961	147,671
GTM	2030-2035	0	17,183	13,010	155,101
MEX	1990-1995	17,459	0	2,462	666,096
MEX	1995-2000	6,766	0	4,206	870,004
MEX	2000-2005	8,388	0	2,318	1,182,244
MEX	2005-2010	8,758	0	3,930	1,584,601
MEX	2010-2015	8,750	0	2,666	1,435,368
MEX	2015-2020	6,719	0	8,202	1,404,933
MEX	2020-2025	5,456	0	10,123	1,410,907
MEX	2025-2030	4,362	0	10,352	1,418,606
MEX	2030-2035	3,259	0	10,526	1,427,320
SLV	1990-1995	23,819	22,137	0	36,849
SLV	1995-2000	13,714	2,041	0	56,673
SLV	2000-2005	3,769	985	0	81,360
SLV	2005-2010	2,652	850	0	100,228
SLV	2010-2015	2,530	1,293	0	118,315
SLV	2015-2020	2,609	1,372	0	130,253
SLV	2020-2025	2,675	1,347	0	134,496
SLV	2025-2030	2,718	1,321	0	137,580
SLV	2030-2035	2,746	1,297	0	140,592
USA	1990-1995	336,502	2,657,149	293,287	0
USA	1995-2000	394,301	3,256,899	368,249	0
USA	2000-2005	312,557	3,309,139	368,123	0
USA	2005-2010	196,824	2,175,437	352,954	0
USA	2010-2015	166,128	1,815,127	329,633	0
USA	2015-2020	199,758	1,740,516	295,591	0
USA	2020-2025	225,486	1,756,420	278,681	0
USA	2025-2030	247,089	1,779,593	265,530	0
USA	2030-2035	267,734	1,804,328	252,337	0

ISO code	Country
SLV	El Salvador
GTM	Guatemala
MEX	Mexico
USA	United States of America

5.2 Global Migration Trends

The previous section discussed results of migration forecasts for Corridor 1 (Central America - Northern America). Here follow some notes on the projection of all countries covered (currently, 194).

Some notes about modeling and projection of origin-destination migration flows are in order. As pointed out in a previous work (Buettner and Muenz 2018b, 2018a), the original multistate model of population projection has an emigration bias, that is it considers only the flow intensities from origin to destination. This does not mean inflows are left missing, as the outflow from a sending country turn inflow at the receiving country. The direction and amount of migration, however, is determined by the sending country alone - hence emigration bias. Several proposals were put forward to include receiving countries into the multistate model (Buettner and Muenz 2018a). In this paper, the focus was put on emigration for the projecting part, for brevity reasons. Moving from total emigration or immigration to origin-destination flows poses problems. An obvious one is the greater complexity for modelling and projecting migratory movements between many countries and maintaining the origin/destination properties. One challenge is that migration figures may be small and may fall under a numeric threshold, while wide fluctuations are more common. Furthermore, the assignment of age and sex attributes (in case they are not known) by using standard models is also problematic, if not impossible. Preliminary tests forecasting absolute migration figures with time series models have occasionally resulted in negative numbers for the projection intervals[8].

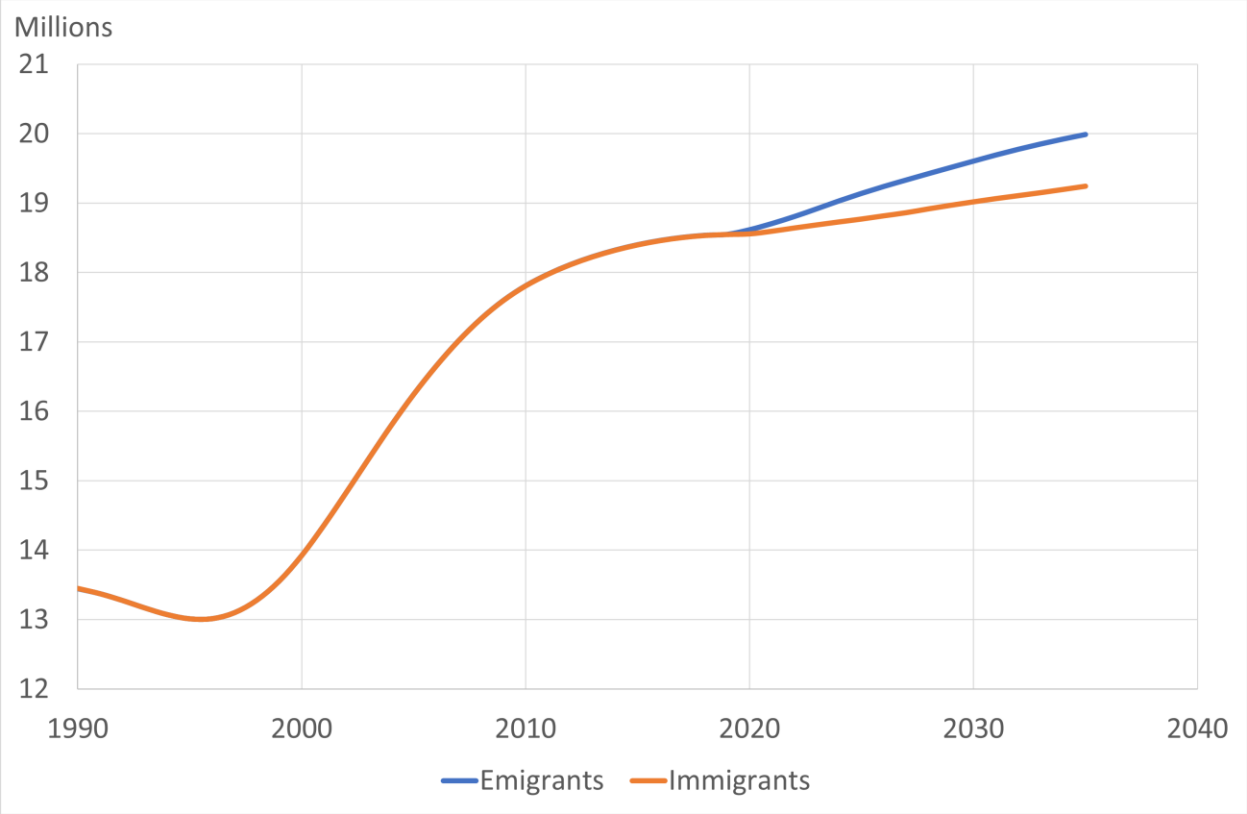
The projections for all 194 countries were carried out independently by time-series models, based on (interpolated) estimates for 1990 to 2019, with a projection horizon in 2035. The procedure included, first, the projection of all origin-destination flows forward as Crude Rates (separately for immigration and emigration), and second, the calculation of total migration figures by multiplying the projected bilateral crude rates with mid-year populations taken from the UN's World Population Projects[9].

Because at this stage, the projections are carried out independently, emigration and emigration figures are not guaranteed to match exactly on the global level. Both emigration and immigration flows continue to rise over the projection horizon, from about 13.6 million in 2019 to 13.6 million in the first projected year - 2020. In in 2035, the projections arrive at about 20 million people annually emigrating and about 19.2 million people immigrating, a difference of 742 thousand. The difference, expressed in relation to immigration, is relatively small: - 4%.

[8] Transformation of the values to prevent negative results yields forecast distributions that may be extremely skewed

[9] There is a certain bias included in this procedure, as the UN's projection already are considering migration (albeit as net migration). The bias would tend to increase the projected migration flow projections for countries and periods with positive net migration and would decrease the results for countries and years with negative net migration. The bias, however, is likely very small. Once the migration projections are integrated in a population projection, this bias would not occur.

Figure 8: Total migrants, 1990 -2019 estimates, 2020-2035 projections



6 Discussion

The preparation of migration flow estimates and their projection in this paper employed simple methods adequate to the data quality. Considering the often volatile and erratic nature of migration streams, the underlying estimates of five-year flows were interpolated into single year estimates, while maintaining their overall level. It is obvious that such formal transformation from a five-year to single year period format cannot reproduce the actual fluctuating and erratic migration streams. Still, it provides researchers and ultimately policy makers a much better underpinning of analysis and decision by allowing to impart major events or shocks, measured empirically or even only in qualitative terms. This is more relevant for countries with limited statistical capacities, of course.

While the methodology used lacks the sophistication and complexity of other migration models that often gravitate towards the countries with robust and reliable time series, using simpler method has the advantage to be useful in cases where migration flow statistics are rare or lacking. Simple approaches have benefits, but also drawbacks. One common challenge to both sophisticated and simple models is the general scarcity of valid international migration statistics. In the case of stock-to-flow estimates, the "long and winding path" from census results on the foreign-born or persons with foreign citizenship to migration flows estimates is complex: it starts by obtaining suitable data from censuses, then move them in time to a common scale, usually for quinquennial years. These data on lifetime migrant stocks (or short: migrant stocks) with the largest international coverage are available for both sexes combined,

and less so by sex. Information of the age composition is still rare. Abel (G. Abel 2009, 2017; G. Abel and Cohen 2019) pioneered the estimation of migration flows estimates from migrant stock data based on the periodic updated datasets of International Migrant Stock (United Nations 2020). This paper extends their work and by a simple and preliminary projection exercise, moving closer the simultaneous and consistent population projections, while at the same time integrating the migration component as bilateral and annualized flows.

As previous work has demonstrated, modelling migration flows as an interaction between sending and admitting/receiving countries will be important (Buettner and Muenz 2018b, 2018a). This paper has, for reasons of keeping the paper within limits of space, concentrated mainly on emigration flows (which, naturally, turn into immigration in admitting countries). Thus, interaction between the two sides of a migration streams was not ensured. The paper endeavored to introduce annual migration flows, especially for developing countries, where such information is rare, even often unavailable. It was found that second-hand flow estimates from stock data resemble recorded statistics of immigration, in some cases, rather well, while for emigration the discrepancies were larger between reported statistics and figures calculated from stock data. A general problem arises with flow estimates for transforming them into single-year time series and, later, when preparing projection: Migration data are in many cases small, even when figures are for both sexes combined, and all age groups collapse to a total figure. It is numerically challenging to transform the small migration events into meaningful age-specific emigration or immigration rates, by sex. It could be useful to treat low-level migration streams differently, that is as total events that would be added to the projection using the cohort-component method. That is, a hybrid approach combining projections by applying classic occurrence/exposure rates with time series projection of total and small events

The challenge of small numbers manifested itself during the projection exercise of this paper by occurrences of negative emigration figure (both for total counts and rates). Applying standard statistical transformations (log, logit, Box-Cox) may help avoiding the problem, but inadvertently produces skewed and implausible projection intervals. Exploring other statistical forecasting models may therefore a viable option.

Another important question for bilateral migration projections is whether to project each combination of bilateral migration streams separately projecting total emigrants and total immigrants (or their rates) first. This would have the benefit of larger migration volumes of or migration rates, which would avoid, at least partially, erratic trends. A second step must then be taken by splitting the aggregate projection figures according to the (known or projected) share of each bilateral stream on the total. The latter approach is clearly more demanding as it divides the projection problem in two parts: Projecting total emigration and total immigration for each country and. second, formulating reasonable assumptions about the spatial distribution of a total migration streams. By separating the overall flow level from its spatial distribution, it seems nevertheless promising and possible to project the distribution matrix itself. Such an approach seems to be an interesting way to make the spatial organization itself subject to projection, and change (see, for example (Willekens 2008, 135).

A final word about context and challenges. The proposed transition to an annual data format is promising a much better reflection of migration's erratic episodes and a more transparent treatment of uncertainty. While technically possible, it is also much more demanding as the amount of data, both for input and output, dramatically increases. In addition, problems are likely to emerge regarding numeric

stability.
The upcoming transition of the UN's World Population Prospects to a single year format could be used as a reference and for validation exercises for both projects. Integrating migration flow projection into the framework of periodically revised estimates and projection would allow for continues improvement of both estimates and projections (for an overview about the evolution of the United Nations World Population Prospects, see (Buettner 2021)).

7 Appendix

The Appendix presents select additional information from the projection exercise. Section 8.1 presents baseline profiles for 15 countries, combining summaries in tabular and charts depicting trends of emigration and emigration, plus the 10 largest immigration and emigration flows associated with the country. Section 8.2 lists the 29 migration corridors and their constituent countries The last two sections provide reference information regarding the statistical models automatically selected for the forecasting of migration flows (8.3), followed by a glossary (8.4) of abbreviations.

7.1 Baseline Profiles

Baseline profiles are limited to 15 select countries (**Table 6**) and presented both as a summary table and charts comparing total emigration and immigration estimates. The charts depicting, first, original quinquennial estimates (as a step function) and, second, interpolated time series. It is to be noted the estimates, in
quinquennial format or annual, are the result of an involved process that include not only raw stock data, possibly with several deficiencies, and procedures and assumptions that may involve several biases, some unknown. Still, as has been stated several times throughout this paper, the data and their depiction in charts are rare, if not solitary, attempts to grasp the actual migratory movements. In short, when looking at the data of migration flows, it is an echo of past events than is being seen as imprinted on static accounts of population censuses.

Table 6: Classifications of Countries in Baseline Profiles

Country	ISO3 Code	Region	Development Group	Income Group
Bangladesh	BGD	Southern Asia	LDR, LDC	MIC
Egypt	EGY	Northern Africa	LDR	MIC
Ethiopia	ETH	Eastern Africa	LDR, LDC, LLDC	LIC
India	IND	Southern Asia	LDR, MIC	MIC
Kazakhstan	KAZ	Central Asia	LDR	MIC
Mali	MLI	Western Africa	LDR, LDC, LLDC	LIC
Mexico	MEX	Central America	LDR	MIC
Morocco	MAR	Northern Africa	LDR	MIC
Myanmar	MMR	South-Eastern Asia	LDC	MDR
Nigeria	NGA	Western Africa	LDR	MIC
Pakistan	PAK	Southern Asia	LDR	MIC
China	CHN	Eastern Asia	LDR	MIC
Philippines	PHL	South-Eastern Asia	LDR	MIC
Senegal	SEN	Western Africa	LDR	LIC
Ukraine	UKR	Eastern Europe	MDR	MIC

Note:

Source: United Nations, Department of Economic and Social Affairs, Population Division: World Population Prospects Database extract. 6/13/2021 3:59:57 PM.

7.1.1 Bangladesh

Table 7: Demographic profile: Bangladesh, 1990-2020

Indicator	1990	1995	2000	2005	2010	2015
Population	103,171,956	115,169,930	127,657,854	139,035,505	147,575,430	156,256,276
Median Age	18.6	19.6	21.0	22.5	24.0	25.7
	1990-1995	**1995-2000**	**2000-2005**	**2005-2010**	**2010-2015**	**2015-2020**
Children per Woman	4.1	3.4	2.9	2.5	2.2	2.1
Life expectancy	59.9	64.0	66.6	68.8	70.8	72.2
Natural change	12,811,772	13,207,821	12,870,189	11,794,704	10,987,684	10,280,608
Net migration	-813,794	-719,899	-1,492,537	-3,254,778	-2,306,839	-1,847,503
Emigration	1,727,799	1,461,109	2,222,391	4,033,815	3,128,049	3,256,745
Immigration	914,511	741,324	729,685	797,617	820,856	1,409,328
Migration Efficiency	-31	-33	-51	-67	-58	-40

Source: United Nations, Department of Economic and Social Affairs, Population Division: World Population Prospects Database extract. 6/13/2021 3:59:57 PM.

Figure 9: Bangladesh: Immigrants and emigrants, by source, 1990-2020

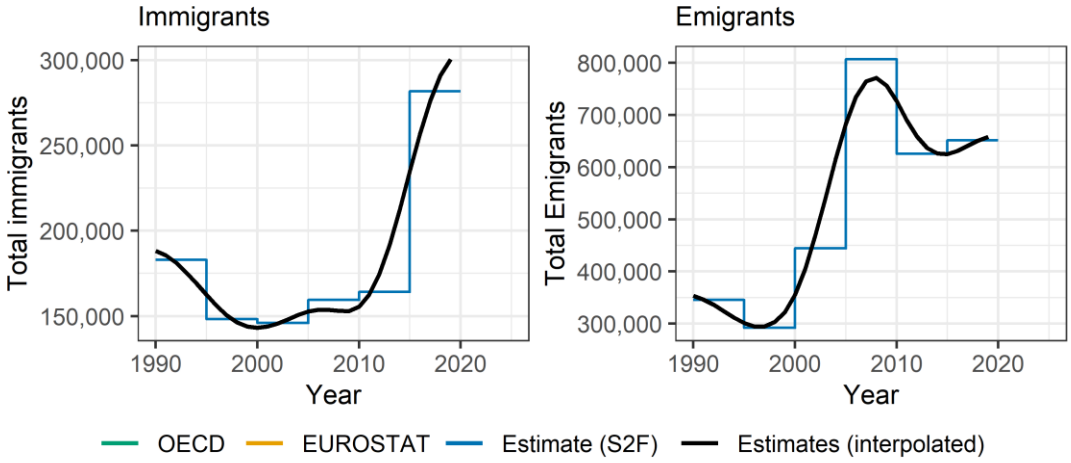
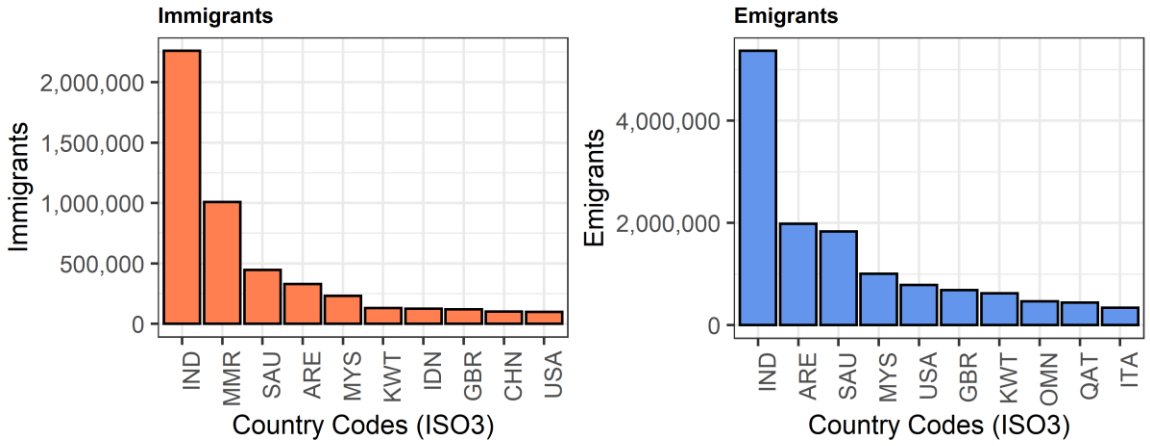


Figure 10: Bangladesh: Ten largest origin and destination countries, 1990-2020



7.1.2 China

Table 8: Demographic profile: China, 1990-2020

Indicator	1990	1995	2000	2005	2010	2015
Population	1,176,883,674	1,240,920,535	1,290,550,765	1,330,776,380	1,368,810,615	1,406,847,870
Median Age	24.9	27.4	30.0	32.6	35.0	36.7
	1990-1995	**1995-2000**	**2000-2005**	**2005-2010**	**2010-2015**	**2015-2020**
Children per Woman	1.8	1.6	1.6	1.6	1.6	1.7
Life expectancy	69.4	70.6	72.3	73.7	75.1	76.6
Natural change	64,816,840	50,013,229	42,191,195	40,212,615	39,589,470	34,217,901
Net migration	-779,982	-382,999	-1,965,578	-2,178,385	-1,552,209	-1,741,996
Emigration	1,553,379	1,390,180	2,699,651	2,926,771	2,746,648	2,939,965
Immigration	631,185	758,126	938,358	1,176,578	1,360,246	1,347,756
Migration Efficiency	-42	-29	-48	-43	-34	-37

Source: United Nations, Department of Economic and Social Affairs, Population Division: World Population Prospects Database extract. 6/13/2021 3:59:57 PM.

Figure 11: China: Immigrants and emigrants, by source, 1990-2020

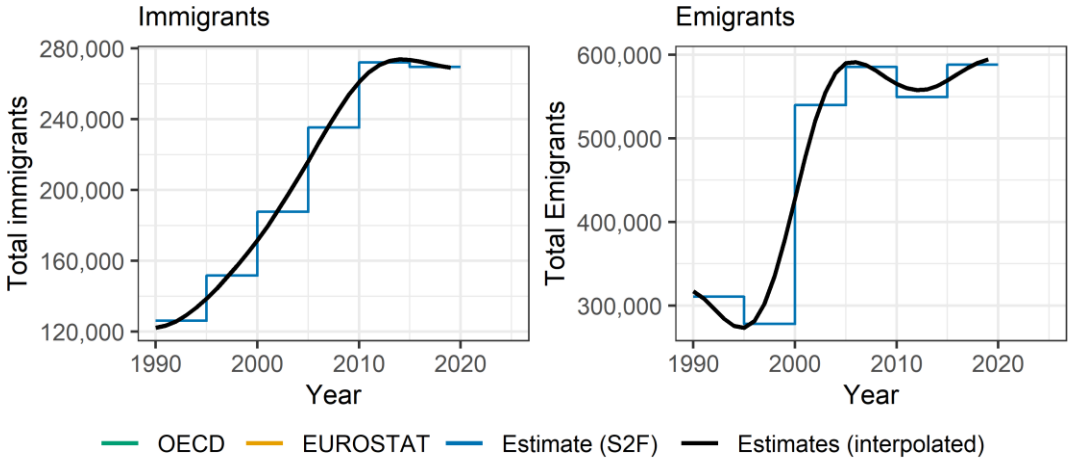
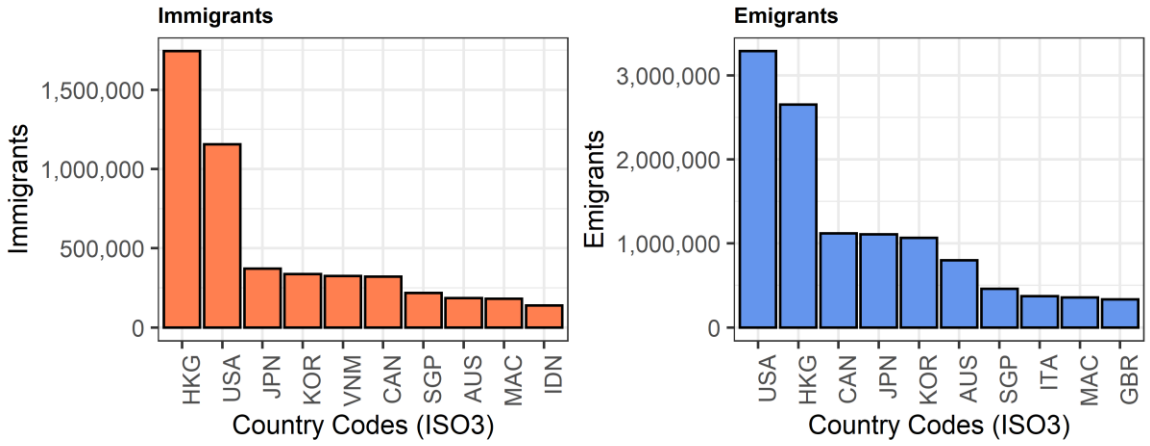


Figure 12: China: Ten largest origin and destination countries, 1990-2020



7.1.3 Egypt

Table 9: Demographic profile: Egypt, 1990-2020

Indicator	1990	1995	2000	2005	2010	2015
Population	56,134,475	62,334,034	68,831,561	75,523,569	82,761,235	92,442,547
Median Age	19.7	20.2	21.1	22.5	23.7	24.3
	1990-1995	**1995-2000**	**2000-2005**	**2005-2010**	**2010-2015**	**2015-2020**
Children per Woman	4.2	3.6	3.2	3.0	3.5	3.3
Life expectancy	65.4	68.0	69.0	69.9	70.8	71.7
Natural change	6,659,958	6,708,424	6,766,478	7,521,240	9,962,254	10,082,016
Net migration	-460,404	-210,899	-74,464	-283,573	-280,944	-190,164
Emigration	620,406	436,346	374,281	638,377	744,844	763,709
Immigration	174,894	224,639	302,724	312,130	454,411	536,717
Migration Efficiency	-56	-32	-11	-34	-24	-17
Source:	United Nations, Department of Economic and Social Affairs, Population Division: World Population Prospects Database extract. 6/13/2021 3:59:57 PM.					

Figure 13: Egypt: Immigrants and emigrants, by source, 1990-2020

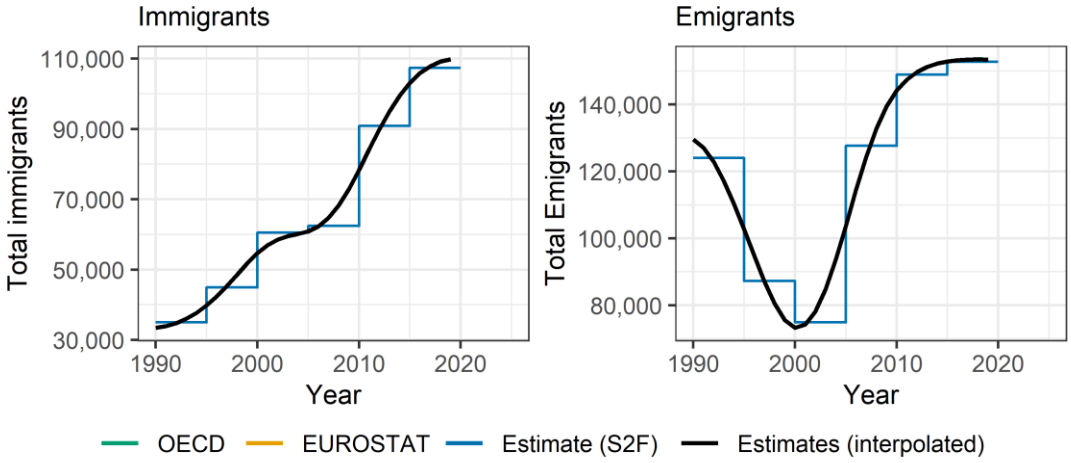
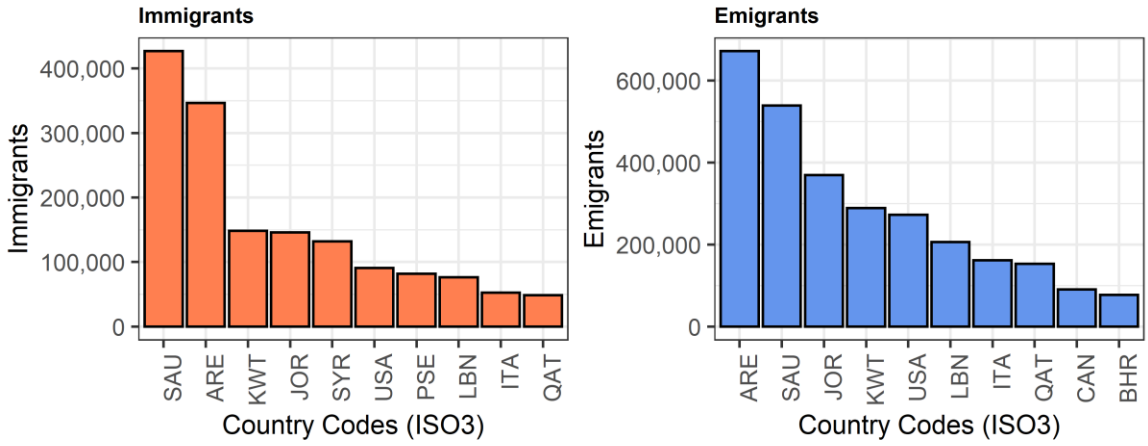


Figure 14: Egypt: Ten largest origin and destination countries, 1990-2020



7.1.4 Ethiopia

Table 10: Demographic profile: Ethiopia, 1990-2020

Indicator	1990	1995	2000	2005	2010	2015
Population	47,887,865	57,047,908	66,224,804	76,346,311	87,639,964	100,835,458
Median Age	16.8	16.7	16.6	16.7	17.3	18.3
	1990-1995	**1995-2000**	**2000-2005**	**2005-2010**	**2010-2015**	**2015-2020**
Children per Woman	7.1	6.8	6.2	5.5	4.9	4.3
Life expectancy	48.1	50.7	53.6	59.1	63.7	66.0
Natural change	7,702,099	9,332,481	10,271,503	11,343,785	12,795,494	13,978,132
Net migration	1,457,943	-155,577	-150,001	-50,132	399,997	150,002
Emigration	86,823	354,459	241,620	219,639	321,096	179,611
Immigration	909,854	83,556	90,768	131,392	360,441	290,171
Migration Efficiency	83	-62	-45	-25	6	24

Source: United Nations, Department of Economic and Social Affairs, Population Division: World Population Prospects Database extract. 6/13/2021 3:59:57 PM.

Figure 15: Ethiopia: Immigrants and emigrants, by source, 1990-2020

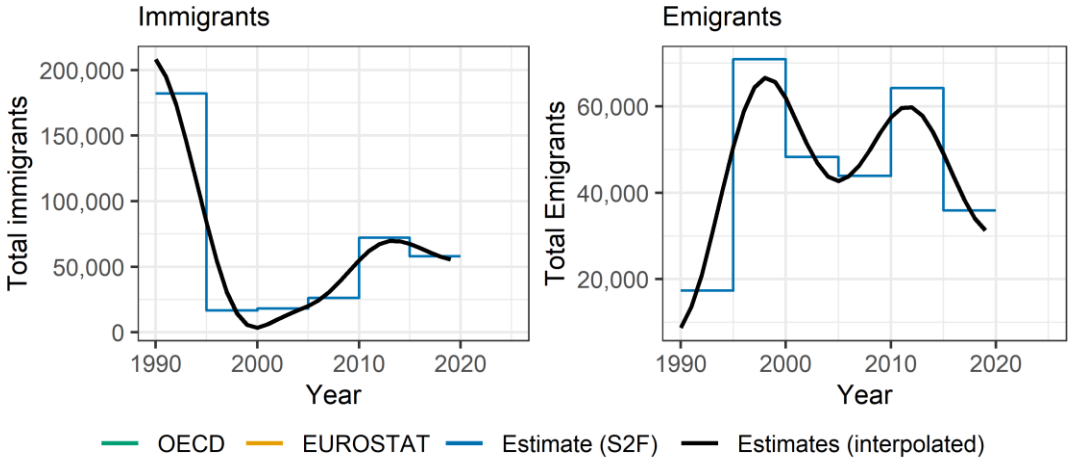
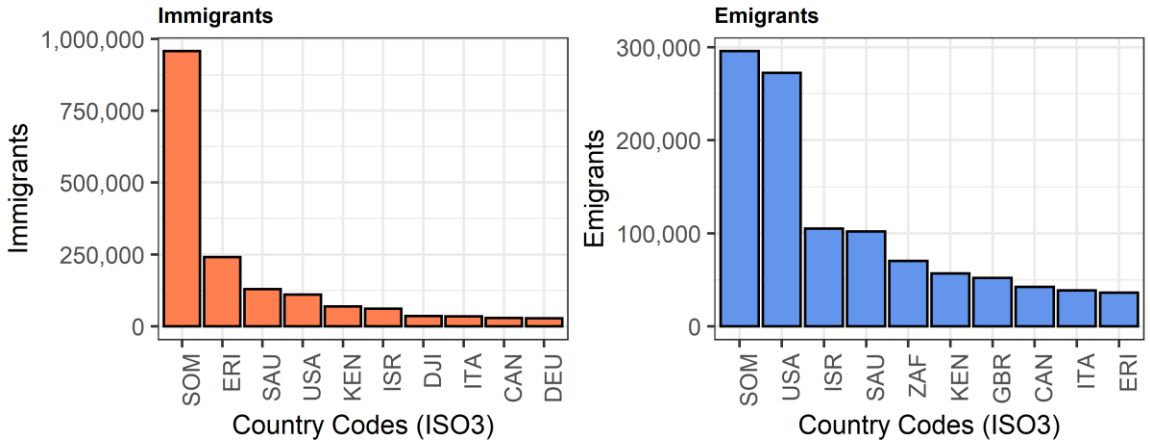


Figure 16: Ethiopia: Ten largest origin and destination countries, 1990-2020



7.1.5 India

Table 11: Demographic profile: India, 1990-2020

Indicator	1990	1995	2000	2005	2010	2015
Population	873,277,798	963,922,588	1,056,575,549	1,147,609,927	1,234,281,170	1,310,152,403
Median Age	21.1	21.8	22.7	23.8	25.1	26.8
	1990-1995	**1995-2000**	**2000-2005**	**2005-2010**	**2010-2015**	**2015-2020**
Children per Woman	3.8	3.5	3.1	2.8	2.4	2.2
Life expectancy	59.1	61.5	63.5	65.5	67.8	69.3
Natural change	91,197,738	93,335,528	92,923,365	89,327,085	78,221,306	72,515,419
Net migration	-552,948	-682,569	-1,888,986	-2,655,844	-2,350,075	-2,663,434
Emigration	3,115,314	2,869,867	4,429,920	5,701,024	5,579,500	5,632,254
Immigration	2,568,026	2,188,146	2,540,183	3,195,619	3,225,721	2,973,180
Migration Efficiency	-10	-13	-27	-28	-27	-31

Source: United Nations, Department of Economic and Social Affairs, Population Division: World Population Prospects Database extract. 6/13/2021 3:59:57 PM.

Figure 17: India: Immigrants and emigrants, by source, 1990-2020

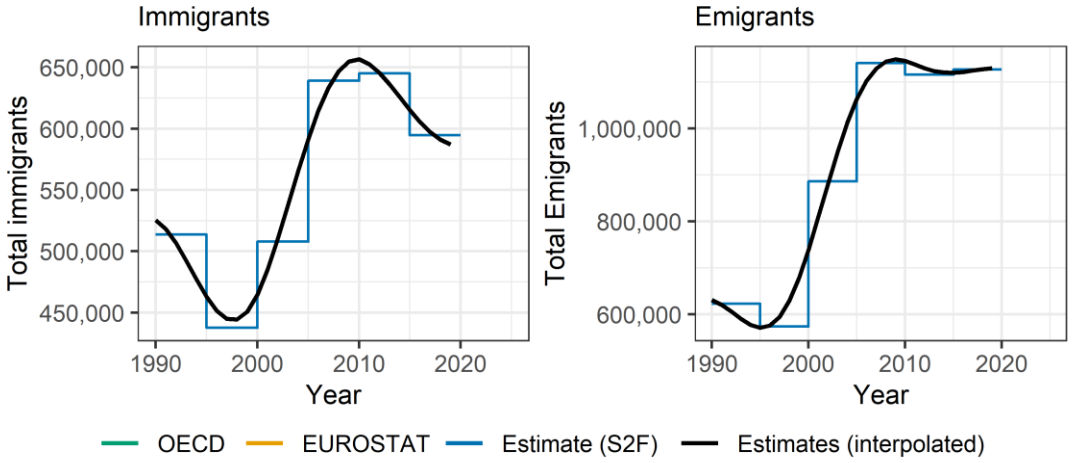
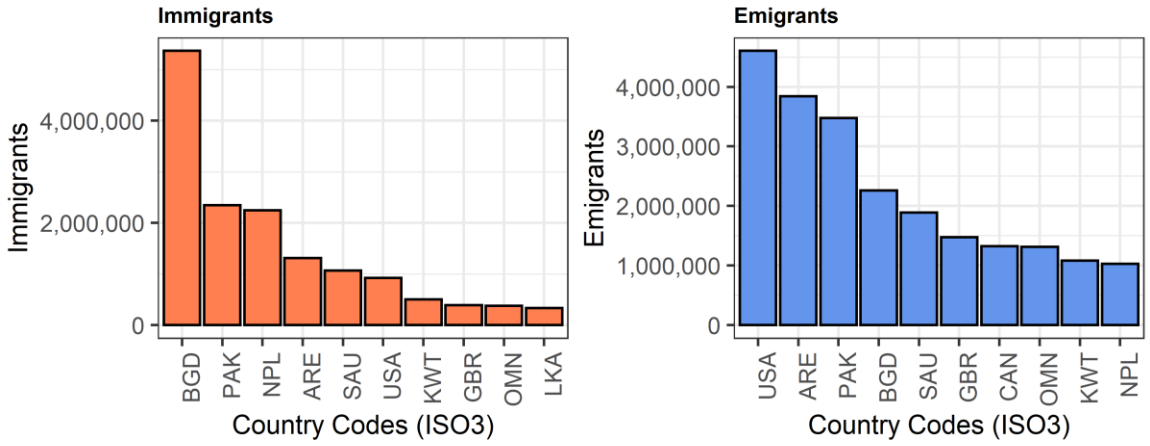


Figure 18: India: Ten largest origin and destination countries, 1990-2020



7.1.6 Kazakhstan

Table 12: Demographic profile: Kazakhstan, 1990-2020

Indicator	1990	1995	2000	2005	2010	2015
Population	16,383,887	15,839,363	14,922,719	15,402,807	16,252,279	17,572,016
Median Age	26.0	27.1	27.8	28.6	28.9	29.4
	1990-1995	**1995-2000**	**2000-2005**	**2005-2010**	**2010-2015**	**2015-2020**
Children per Woman	2.6	2.0	2.0	2.5	2.7	2.8
Life expectancy	65.5	63.0	64.6	66.1	69.1	73.2
Natural change	894,874	344,868	435,557	884,665	1,159,931	1,294,694
Net migration	-1,439,396	-1,261,512	44,530	-35,196	159,807	-90,000
Emigration	2,077,430	1,903,684	957,593	955,384	910,139	1,096,355
Immigration	638,823	642,199	1,001,698	921,717	1,069,525	1,006,317
Migration Efficiency	-53	-50	2	-2	8	-4

Source: United Nations, Department of Economic and Social Affairs, Population Division: World Population Prospects Database extract. 6/13/2021 3:59:57 PM.

Figure 19: Kazakhstan: Immigrants and emigrants, by source, 1990-2020

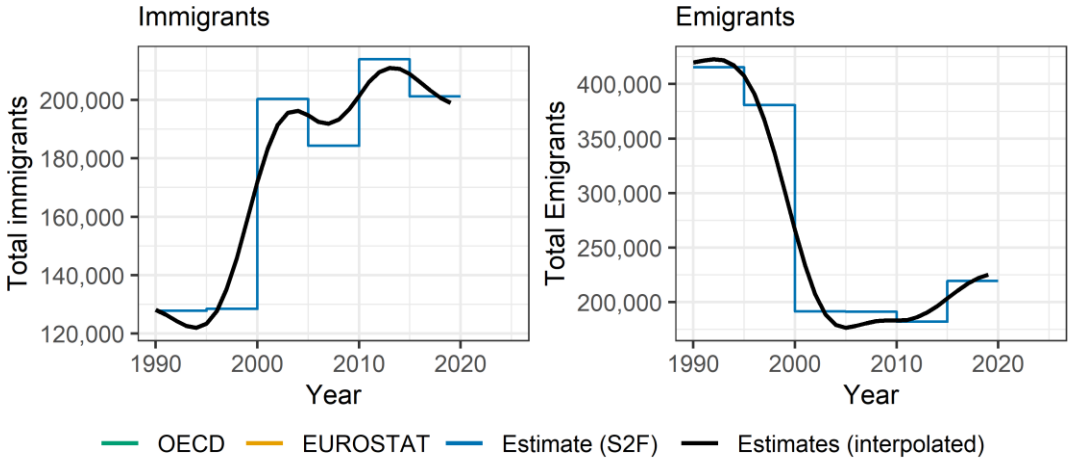
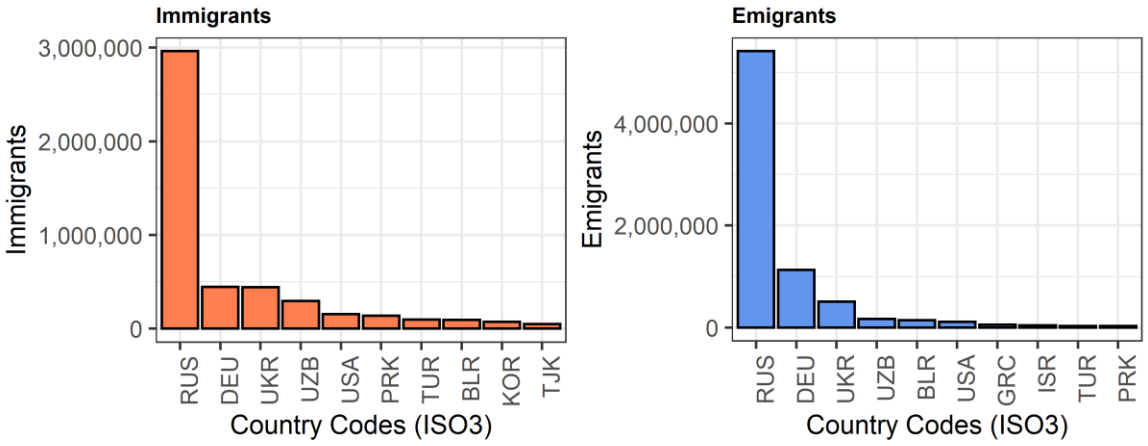


Figure 20: Kazakhstan: Ten largest origin and destination countries, 1990-2020



7.1.7 Mali

Table 13: Demographic profile: Mali, 1990-2020

Indicator	1990	1995	2000	2005	2010	2015
Population	8,449,913	9,585,653	10,946,445	12,775,516	15,049,353	17,438,778
Median Age	16.5	16.5	16.6	16.5	16.2	16.0
	1990-1995	**1995-2000**	**2000-2005**	**2005-2010**	**2010-2015**	**2015-2020**
Children per Woman	7.2	7.0	6.9	6.7	6.4	5.9
Life expectancy	46.6	46.8	50.0	54.0	56.2	58.7
Natural change	1,309,232	1,502,745	1,896,177	2,374,659	2,691,869	3,012,064
Net migration	-173,489	-141,950	-67,110	-100,823	-302,449	-200,000
Emigration	317,709	244,541	265,444	366,730	529,593	442,846
Immigration	145,595	102,597	198,712	266,825	227,353	242,862
Migration Efficiency	-37	-41	-14	-16	-40	-29
Source:	United Nations, Department of Economic and Social Affairs, Population Division: World Population Prospects Database extract. 6/13/2021 3:59:57 PM.					

Figure 21: Mali: Immigrants and emigrants, by source, 1990-2020

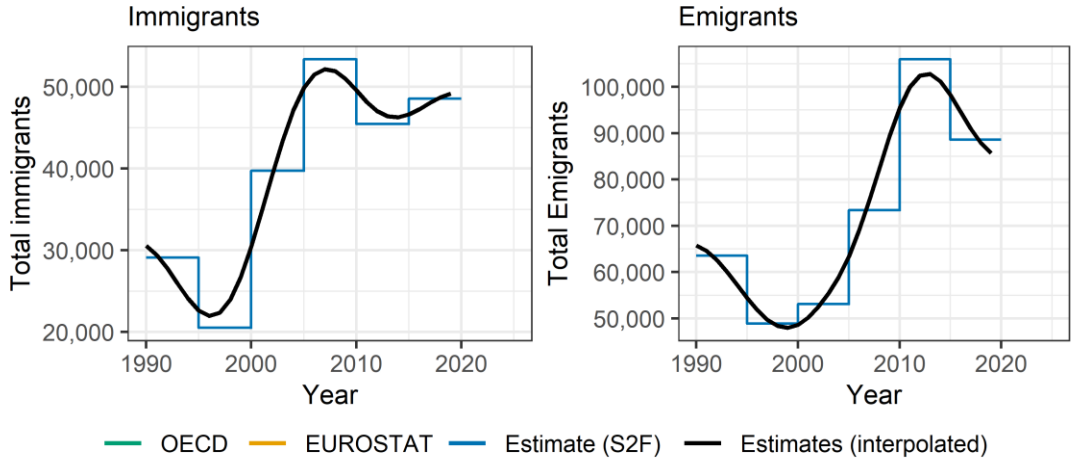
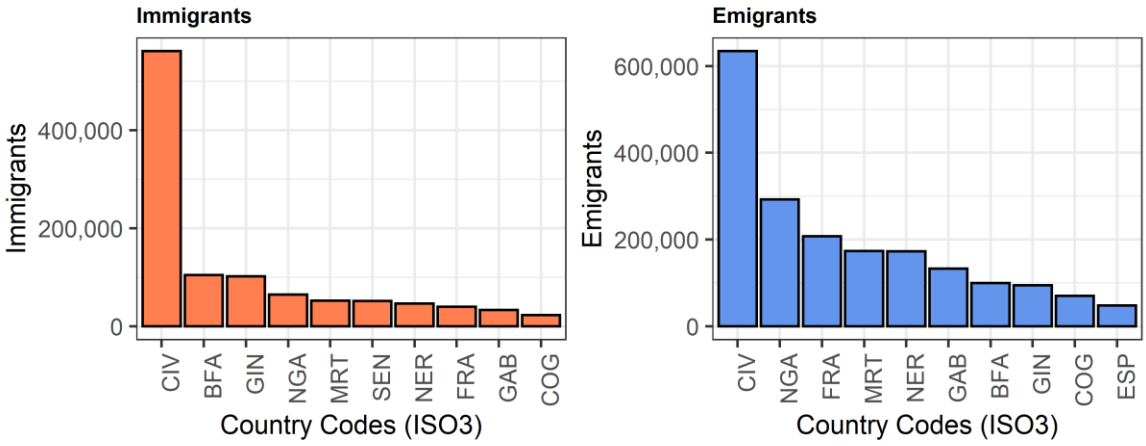


Figure 22: Mali: Ten largest origin and destination countries, 1990-2020



7.1.8 Mexico

Table 14: Demographic profile: Mexico, 1990-2020

Indicator	1990	1995	2000	2005	2010	2015
Population	83,943,132	91,663,285	98,899,845	106,005,203	114,092,963	121,858,258
Median Age	19.7	21.3	22.9	24.7	26.2	27.7
	1990-1995	**1995-2000**	**2000-2005**	**2005-2010**	**2010-2015**	**2015-2020**
Children per Woman	3.2	2.9	2.6	2.4	2.3	2.1
Life expectancy	71.8	73.3	75.1	75.2	74.9	75.0
Natural change	9,738,691	9,533,024	9,311,469	8,650,167	8,187,765	7,374,499
Net migration	-2,018,533	-2,296,470	-2,206,114	-562,404	-422,477	-300,000
Emigration	2,761,849	3,313,331	3,459,611	2,264,766	1,954,595	1,875,485
Immigration	743,736	1,016,824	1,253,384	1,716,515	1,531,722	1,575,368
Migration Efficiency	-58	-53	-47	-14	-12	-9
Source:	United Nations, Department of Economic and Social Affairs, Population Division: World Population Prospects Database extract. 6/13/2021 3:59:57 PM.					

Figure 23: Mexico: Immigrants and emigrants, by source, 1990-2020

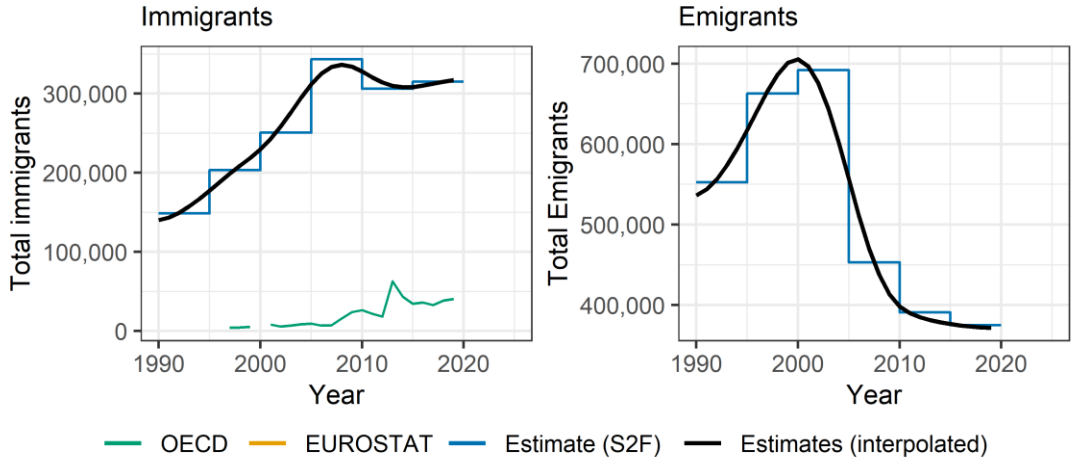
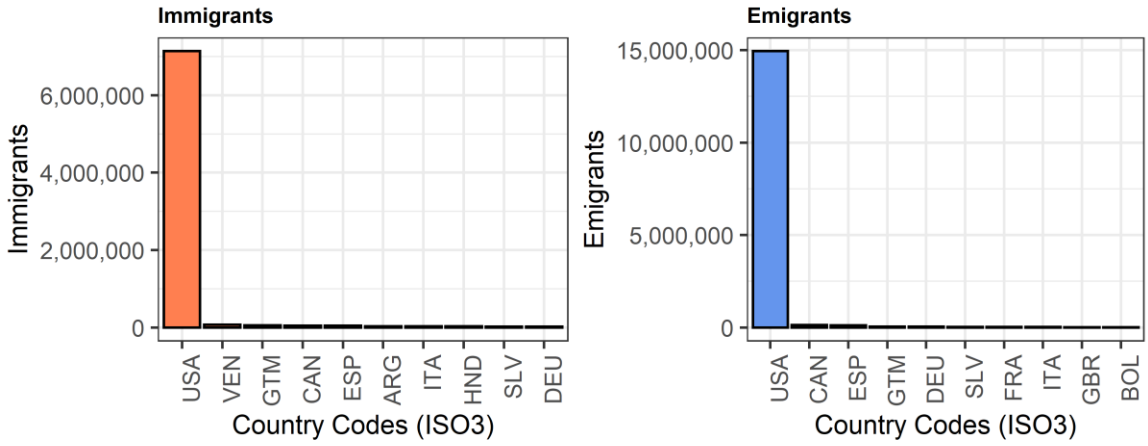


Figure 24: Mexico: Ten largest origin and destination countries, 1990-2020



7.1.9 Morocco

Table 15: Demographic profile: Morocco, 1990-2020

Indicator	1990	1995	2000	2005	2010	2015
Population	24,807,462	26,994,250	28,793,679	30,455,561	32,343,389	34,663,603
Median Age	19.8	21.1	22.7	24.5	26.4	27.9
	1990-1995	**1995-2000**	**2000-2005**	**2005-2010**	**2010-2015**	**2015-2020**
Children per Woman	3.7	3.0	2.7	2.5	2.6	2.4
Life expectancy	66.0	67.6	70.0	73.4	75.0	76.3
Natural change	2,653,419	2,332,004	2,316,706	2,452,970	2,687,317	2,504,055
Net migration	-466,627	-532,581	-654,821	-565,140	-367,108	-257,096
Emigration	658,900	739,407	888,768	858,680	708,214	625,452
Immigration	192,450	206,845	233,923	297,591	341,024	368,322
Migration Efficiency	-55	-56	-58	-49	-35	-26
Source:	United Nations, Department of Economic and Social Affairs, Population Division: World Population Prospects Database extract. 6/13/2021 3:59:57 PM.					

Figure 25: Morocco: Immigrants and emigrants, by source, 1990-2020

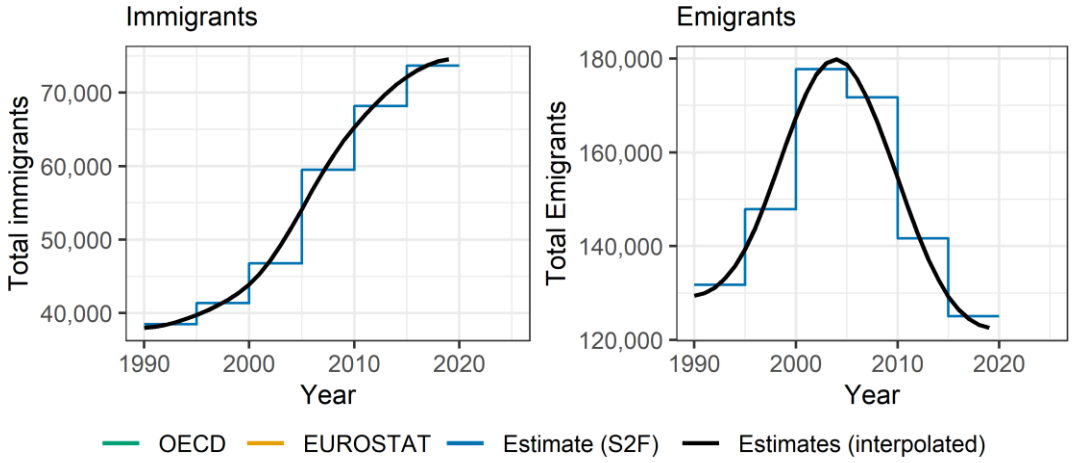
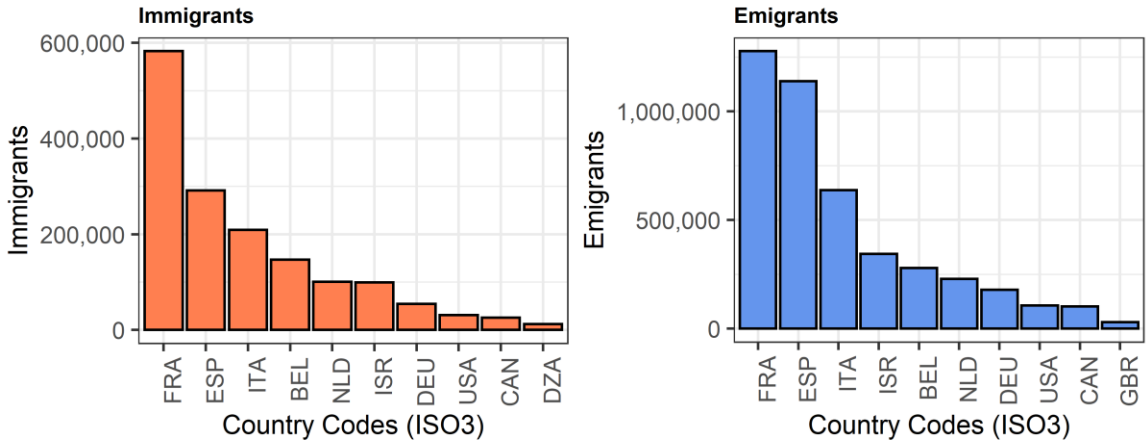


Figure 26: Morocco: Ten largest origin and destination countries, 1990-2020



7.1.10 Myanmar

Table 16: Demographic profile: Myanmar, 1990-2020

Indicator	1990	1995	2000	2005	2010	2015
Population	41,335,199	43,901,598	46,719,701	48,949,924	50,600,818	52,680,726
Median Age	20.7	22.0	23.3	24.5	26.1	27.5
	1990-1995	**1995-2000**	**2000-2005**	**2005-2010**	**2010-2015**	**2015-2020**
Children per Woman	3.2	3.0	2.8	2.5	2.3	2.2
Life expectancy	57.7	59.3	60.9	62.4	64.7	66.8
Natural change	3,280,104	3,356,098	3,438,317	2,987,826	2,608,121	2,545,633
Net migration	-713,704	-537,998	-1,208,092	-1,336,928	-528,211	-816,564
Emigration	786,745	650,975	1,327,949	1,515,954	826,393	1,173,859
Immigration	73,422	113,013	119,833	185,478	298,019	357,251
Migration Efficiency	-83	-70	-83	-78	-47	-53
Source:	United Nations, Department of Economic and Social Affairs, Population Division: World Population Prospects Database extract. 6/13/2021 3:59:57 PM.					

Figure 27: Myanmar: Immigrants and emigrants, by source, 1990-2020

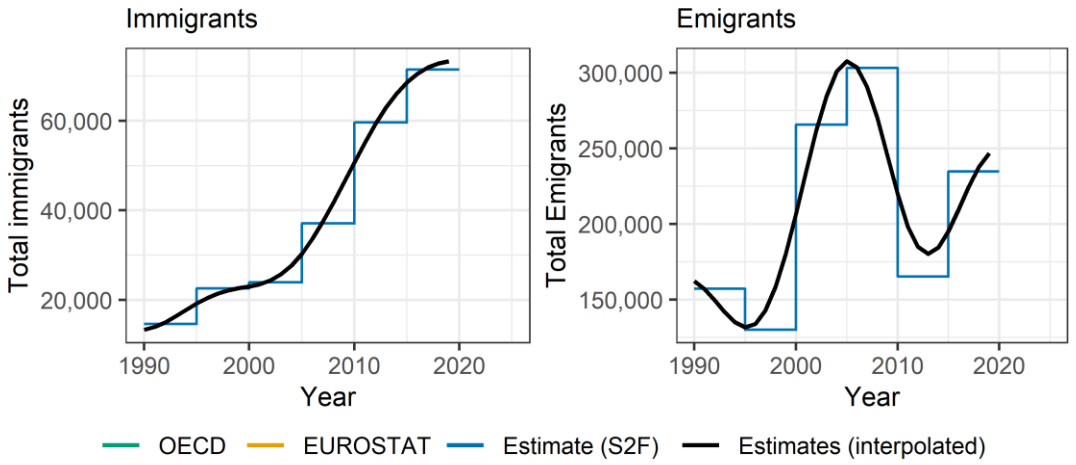
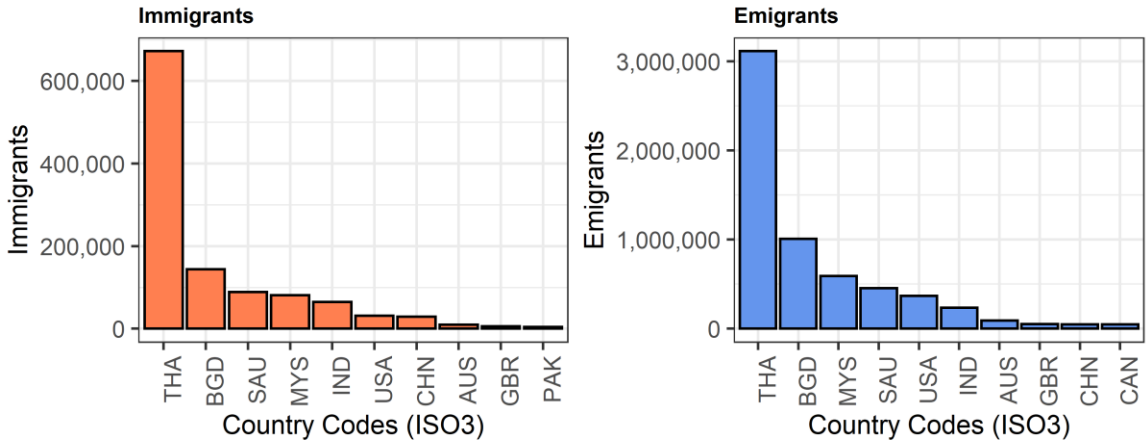


Figure 28: Myanmar: Ten largest origin and destination countries, 1990-2020



7.1.11 Nigeria

Table 17: Demographic profile: Nigeria, 1990-2020

Indicator	1990	1995	2000	2005	2010	2015
Population	95,212,450	107,948,335	122,283,850	138,865,016	158,503,197	181,137,448
Median Age	17.4	17.7	17.9	18.0	17.9	17.9
	1990-1995	**1995-2000**	**2000-2005**	**2005-2010**	**2010-2015**	**2015-2020**
Children per Woman	6.4	6.2	6.1	5.9	5.7	5.4
Life expectancy	45.9	46.0	46.9	49.8	52.0	54.2
Natural change	12,831,651	14,430,543	16,751,166	19,938,184	22,934,248	25,302,141
Net migration	-95,769	-95,027	-170,000	-300,000	-300,000	-300,000
Emigration	263,669	272,972	536,971	580,634	751,402	748,190
Immigration	191,822	176,812	380,739	292,805	451,996	450,589
Migration Efficiency	-16	-21	-17	-33	-25	-25
Source:	United Nations, Department of Economic and Social Affairs, Population Division: World Population Prospects Database extract. 6/13/2021 3:59:57 PM.					

Figure 29: Nigeria: Immigrants and emigrants, by source, 1990-2020

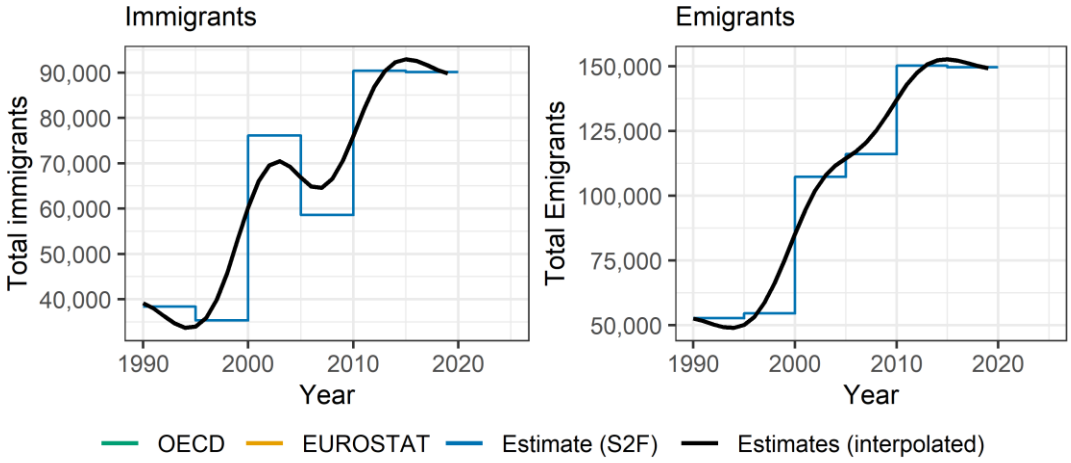
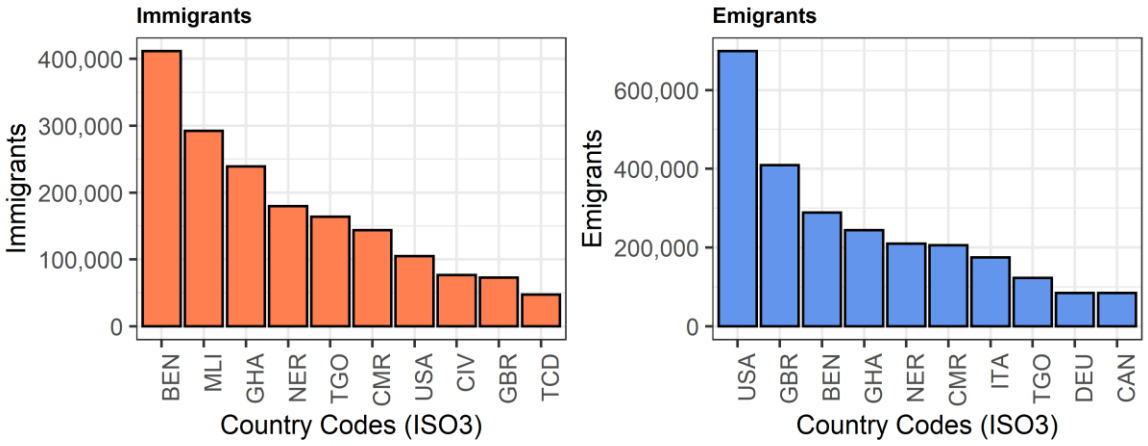


Figure 30: Nigeria: Ten largest origin and destination countries, 1990-2020



7.1.12 Pakistan

Table 18: Demographic profile: Pakistan, 1990-2020

Indicator	1990	1995	2000	2005	2010	2015
Population	107,647,921	123,776,839	142,343,578	160,304,008	179,424,641	199,426,964
Median Age	18.5	18.4	18.8	19.6	20.7	21.8
	1990-1995	**1995-2000**	**2000-2005**	**2005-2010**	**2010-2015**	**2015-2020**
Children per Woman	6.0	5.4	4.7	4.2	3.8	3.6
Life expectancy	60.8	62.2	63.4	64.5	66.0	67.0
Natural change	17,152,311	18,095,832	18,610,613	19,460,436	21,081,485	22,632,271
Net migration	-1,023,387	470,909	-650,182	-339,805	-1,079,167	-1,166,895
Emigration	2,779,516	1,201,955	1,794,383	2,041,932	2,158,244	2,259,301
Immigration	1,756,627	1,672,984	1,144,012	1,723,723	1,078,526	1,092,253
Migration Efficiency	-23	16	-22	-8	-33	-35
Source:	United Nations, Department of Economic and Social Affairs, Population Division: World Population Prospects Database extract. 6/13/2021 3:59:57 PM.					

Figure 31: Pakistan: Immigrants and emigrants, by source, 1990-2020

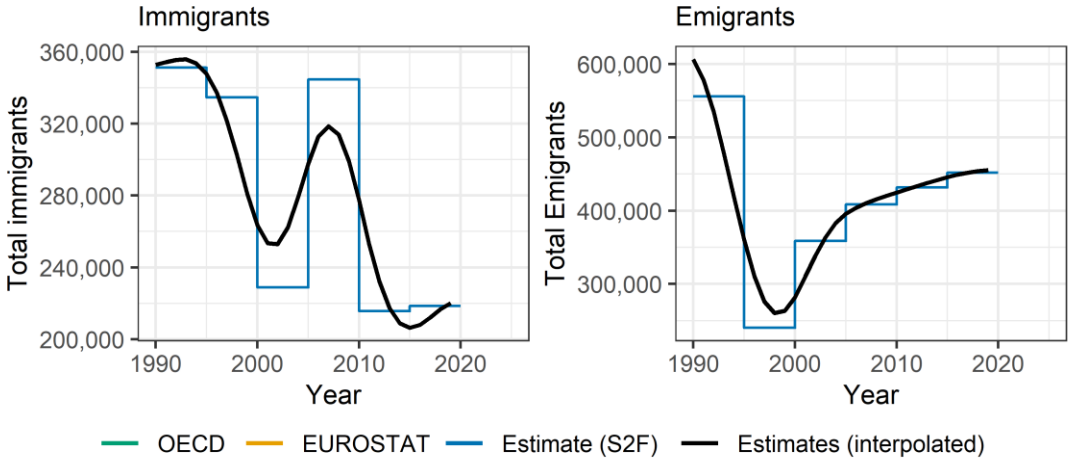
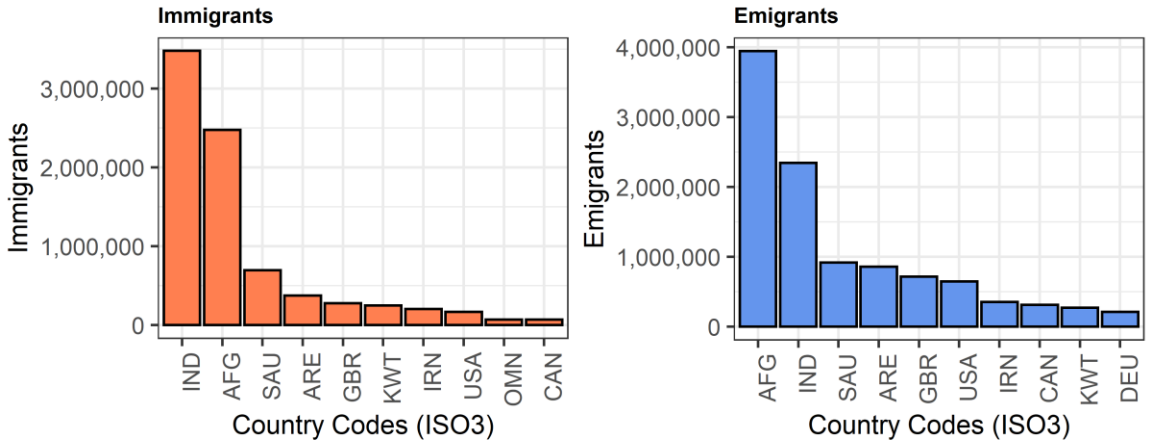


Figure 32: Pakistan: Ten largest origin and destination countries, 1990-2020



7.1.13 Philippines

Table 19: Demographic profile: Philippines, 1990-2020

Indicator	1990	1995	2000	2005	2010	2015
Population	61,895,160	69,784,088	77,991,755	86,326,250	93,966,780	102,113,212
Median Age	19.2	19.8	20.5	21.3	23.1	24.1
	1990-1995	**1995-2000**	**2000-2005**	**2005-2010**	**2010-2015**	**2015-2020**
Children per Woman	4.1	3.9	3.7	3.3	3.1	2.6
Life expectancy	67.5	68.6	68.9	69.4	70.2	71.0
Natural change	8,587,803	9,157,011	9,578,846	9,188,615	8,981,043	7,803,635
Net migration	-698,877	-949,346	-1,244,356	-1,548,077	-834,619	-335,758
Emigration	978,605	1,320,611	1,606,021	2,000,619	1,423,404	1,054,640
Immigration	280,057	371,316	361,626	464,309	588,495	718,782
Migration Efficiency	-55	-56	-63	-62	-41	-19

Source: United Nations, Department of Economic and Social Affairs, Population Division: World Population Prospects Database extract. 6/13/2021 3:59:57 PM.

Figure 33: Philippines: Immigrants and emigrants, by source, 1990-2020

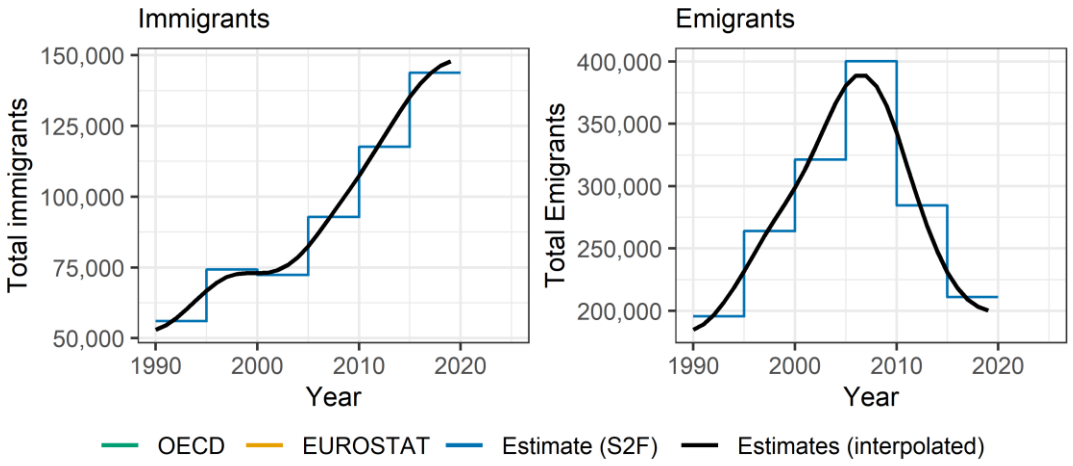
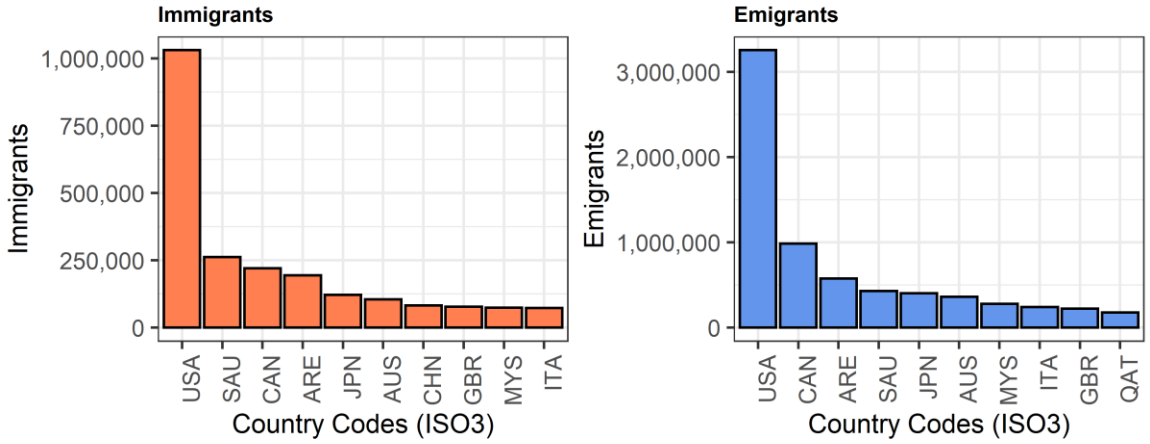


Figure 34: Philippines: Ten largest origin and destination countries, 1990-2020



7.1.14 Senegal

Table 20: Demographic profile: Senegal, 1990-2020

Indicator	1990	1995	2000	2005	2010	2015
Population	7,526,307	8,690,164	9,797,734	11,090,116	12,678,148	14,578,459
Median Age	16.5	16.9	17.3	17.8	18.0	18.1
	1990-1995	**1995-2000**	**2000-2005**	**2005-2010**	**2010-2015**	**2015-2020**
Children per Woman	6.2	5.7	5.3	5.1	5.0	4.7
Life expectancy	57.6	57.2	58.9	62.5	65.7	67.5
Natural change	1,240,858	1,335,125	1,494,875	1,806,039	2,114,310	2,265,474
Net migration	-77,004	-227,553	-202,487	-218,014	-214,002	-100,001
Emigration	221,106	287,660	273,723	307,425	323,396	215,637
Immigration	144,192	60,145	71,271	90,907	109,349	115,630
Migration Efficiency	-21	-65	-59	-54	-49	-30
Source:	United Nations, Department of Economic and Social Affairs, Population Division: World Population Prospects Database extract. 6/13/2021 3:59:57 PM.					

Figure 35: Senegal: Immigrants and emigrants, by source, 1990-2020

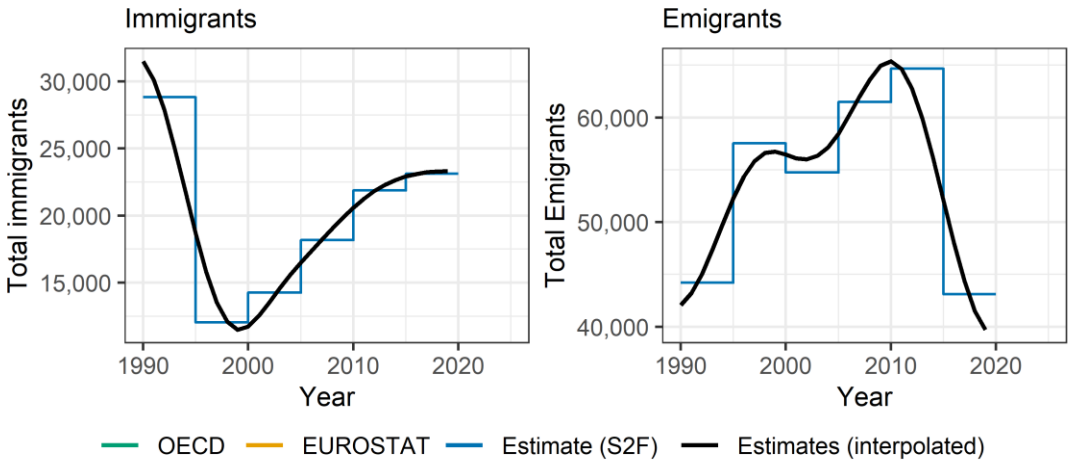
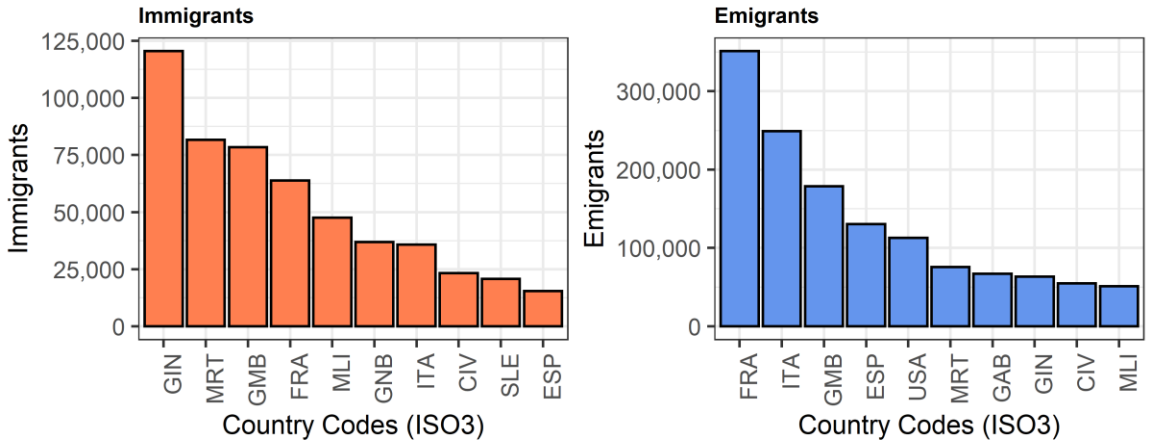


Figure 36: Senegal: Ten largest origin and destination countries, 1990-2020



7.1.15 Ukraine

Table 21: Demographic profile: Ukraine, 1990-2020

Indicator	1990	1995	2000	2005	2010	2015
Population	51,463,105	50,903,785	48,838,065	46,890,772	45,792,090	44,921,639
Median Age	35.3	36.4	37.8	39.1	39.5	40.0
	1990-1995	**1995-2000**	**2000-2005**	**2005-2010**	**2010-2015**	**2015-2020**
Children per Woman	1.6	1.2	1.1	1.4	1.5	1.4
Life expectancy	68.7	67.4	67.5	67.9	70.9	71.8
Natural change	-633,743	-1,603,457	-1,781,849	-1,368,223	-1,002,608	-1,237,872
Net migration	74,421	-462,264	-165,445	269,541	132,154	50,001
Emigration	1,513,494	1,925,192	1,425,294	1,194,885	1,342,156	1,472,406
Immigration	1,588,436	1,462,951	1,259,712	1,469,438	1,473,730	1,522,339
Migration Efficiency	2	-14	-6	10	5	2
Source:	United Nations, Department of Economic and Social Affairs, Population Division: World Population Prospects Database extract. 6/13/2021 3:59:57 PM.					

Figure 37: Ukraine: Immigrants and emigrants, by source, 1990-2020

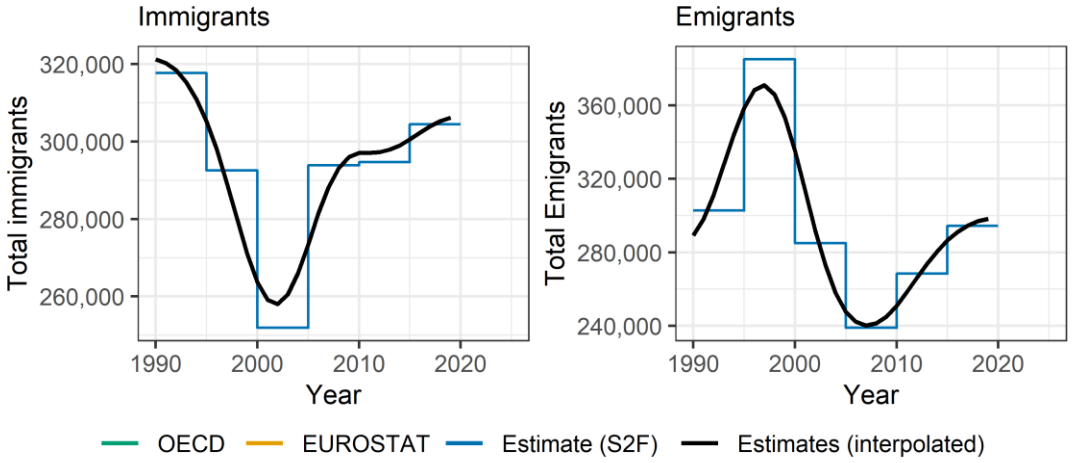
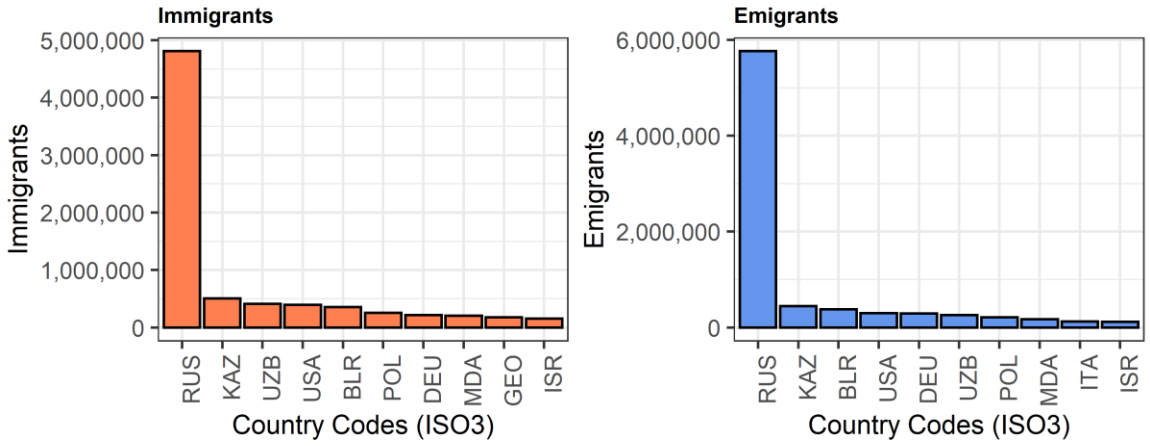


Figure 38: Ukraine: Ten largest origin and destination countries, 1990-2020



7.2 Composition of Migration Corridors

ID	Migration Corridors, countries	ISO3
1	**Central America - Northern America**	
	El Salvador	SLV
	Guatemala	GTM
	Mexico	MEX
	USA	USA
2	**South America - Northern America**	
	Peru	PER
	USA	USA
3	**South America**	
	Colombia	COL
	Venezuela	VEN
4	**Caribbean - Northern America**	
	Cuba	CUB
	Dominican Republic	DOM
	Puerto Rico	PRI
	USA	USA
5	**Northern America**	
	Canada	CAN
	USA	USA
6	**Eastern Europe**	
	Belarus	BLR
	Russian Federation	RUS
	Ukraine	UKR
7	**Central Asia - Eastern Europe**	
	Kazakhstan	KAZ
	Kyrgyzstan	KGZ
	Russian Federation	RUS
	Tajikistan	TJK
	Uzbekistan	UZB
8	**Western Asia - Eastern Europe**	
	Armenia	ARM
	Georgia	GEO
	Russian Federation	RUS
9	**Southern Asia - Northern America**	
	Canada	CAN
	India	IND
	USA	USA
10	**Southern Asia**	
	Afghanistan	AFG
	Bangladesh	BGD
	India	IND
	Iran	IRN
	Nepal	NPL
	Pakistan	PAK
11	**Southern Asia - Western Asia**	
	Bangladesh	BGD
	India	IND
	Kuwait	KWT
	Oman	OMN
	Pakistan	PAK
	Qatar	QAT
	Saudi Arabia	SAU
	United Arab Emirates	ARE

ID	Migration Corridors, countries	ISO3
12	**Western Asia**	
	Iraq	IRQ
	Jordan	JOR
	Lebanon	LBN
	State of Palestine	PSE
	Syria	SYR
	Turkey	TUR
13	**Eastern Asia - Northern America**	
	Canada	CAN
	PR China	CHN
	Republic of Korea	KOR
	USA	USA
14	**South Eastern Asia - Northern America**	
	Canada	CAN
	Philippines	PHL
	USA	USA
	Vietnam	VNM
15	**South Eastern Asia**	
	Indonesia	IDN
	Malaysia	MYS
	Myanmar	MMR
	Singapore	SGP
	Thailand	THA
16	**Eastern Asia**	
	Hong Kong SAR	HKG
	Japan	JPN
	PR China	CHN
	Republic of Korea	KOR
17	**Western Asia - Europe**	
	Germany	DEU
	Turkey	TUR
18	**Southern Africa**	
	Burkina Faso	BFA
	Côte d'Ivoire	CIV
19	**South Eastern Asia - Western Asia**	
	Indonesia	IDN
	Saudi Arabia	SAU
20	**Europe - Eastern Europe**	
	Germany	DEU
	Russian Federation	RUS
21	**Northern America - Europe**	
	Germany	DEU
	Great Britain	GBR
	USA	USA
22	**Europe**	
	Germany	DEU
	Italy	ITA
	Poland	POL
	Romania	ROU
23	**Southern Asia - Europe**	
	Great Britain	GBR
	India	IND

ID	Migration Corridors, countries	ISO3
24	**Northern Africa - Europe**	
	Algeria	DZA
	France	FRA
	Morocco	MAR
	Spain	ESP
25	**Eastern Africa - Middle Africa**	
	DR Congo	COD
	Rwanda	RWA
26	**Eastern Africa - Southern Africa**	
	South Africa	ZAF
	Zimbabwe	ZWE
27	**Europe - Australia/New Zealand**	
	Australia	AUS
	Great Britain	GBR
28	**Southern Asia - South Eastern Asia**	
	Bangladesh	BGD
	Malaysia	MYS
29	**Central Asia - Europe**	
	Germany	DEU
	Kazakhstan	KAZ

7.3 Origin-Destination Format

Migration flows within corridors are presented as origin by destination tables. Migration streams flow down columns (origins) to rows (destination), thus appearing as emigration. As a country does not have a migration stream with itself, the intersection are shown as zero. Table 22 shows the complete movements for the period 1990-1995 between the countries of Corridor 1 as emigration from origin/sending to destination/receiving country. A simple transposition of the table displays the same figures as immigration from sending to receiving country.

Table 22: Origin-destination format, Corridor1, 1990-1995

Countries	**GTM**	**MEX**	**SLV**	**USA**	
		Origin			**Total Immigration**
GTM	0	7,796	15,922	22,849	46,567
MEX	17,459	0	2,462	666,096	686,017
SLV	23,819	22,137	0	36,849	82,805
USA	336,502	2,657,149	293,287	0	3,286,938
Total emigration	377,780	2,687,082	311,671	725,794	4,102,327

			Destination		
	GTM	**MEX**	**SLV**	**USA**	**Total emigration**
GTM	0	17,459	23,819	336,502	377,780
MEX	7,796	0	22,137	2,657,149	2,687,082
SLV	15,922	2,462	0	293,287	311,671
USA	22,849	666,096	36,849	0	725,794
Total immigration	46,567	686,017	82,805	3,286,938	4,102,327

ISO code	Country
GTM	Guatemala
MEX	Mexico
SLV	El Salvador
USA	United States of America
Source:	Authors calculations.

For example, take the flows from or to Guatemala in Table 22 for the five years 1990-1995: 17,459 people are estimated to have emigrated from Guatemala (GTM) to Mexico (MEX), 23,819 to El Salvador (SLV), and 336,502 people to the United States (USA). Changing perspective to immigration or destination-from-origin, Table 22 in its second part shows 7,796 people immigrated from Mexico to Guatemala, 15,922 moved from El Salvador to Guatemala, and 22,849 came from the United States. Finally, summing emigration and immigration from and to Guatemala in 1990-1995 yields 377,780 emigrants from Guatemala to the other countries of Corridor 1, and 46,567 people from Corridor 1 countries immigrated to Guatemala. Guatemala thus had a migration balance, or net migration, of -331,213.

7.4 Migration Rates, Corridor 1

The projection exercise described in this paper used a relative measure of migration flows - the Crude Emigration and Crude Immigration Rate - for projecting the time series of past trends 16 years forward. Choosing a relative measure was an attempt to rest the projections on a more comparable metric. The crude rates were calculated by dividing the annualized bilateral migration figures for the period 1990-2019 by the respective total midyear population (or person-years-lived). Flows from origin to destination (emigration) were divided by the population of the origin country; flows to destination countries from origin countries were divided by the population of destination country. This section shows the Crude Immigration and Emigration Rates for Corridor 1 only.

Figure 39: Crude Immigration Rates 1990-2035 by Country, Corridor 1

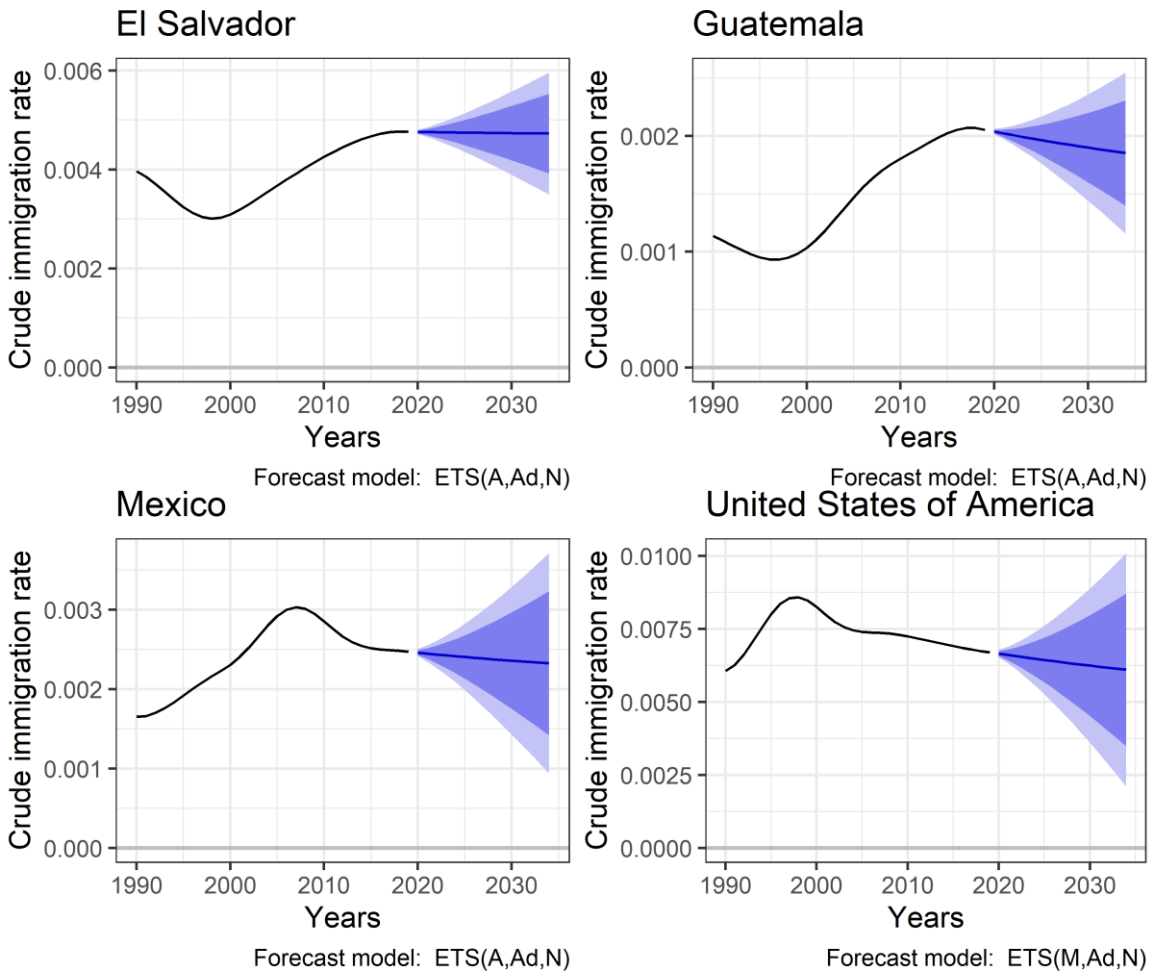
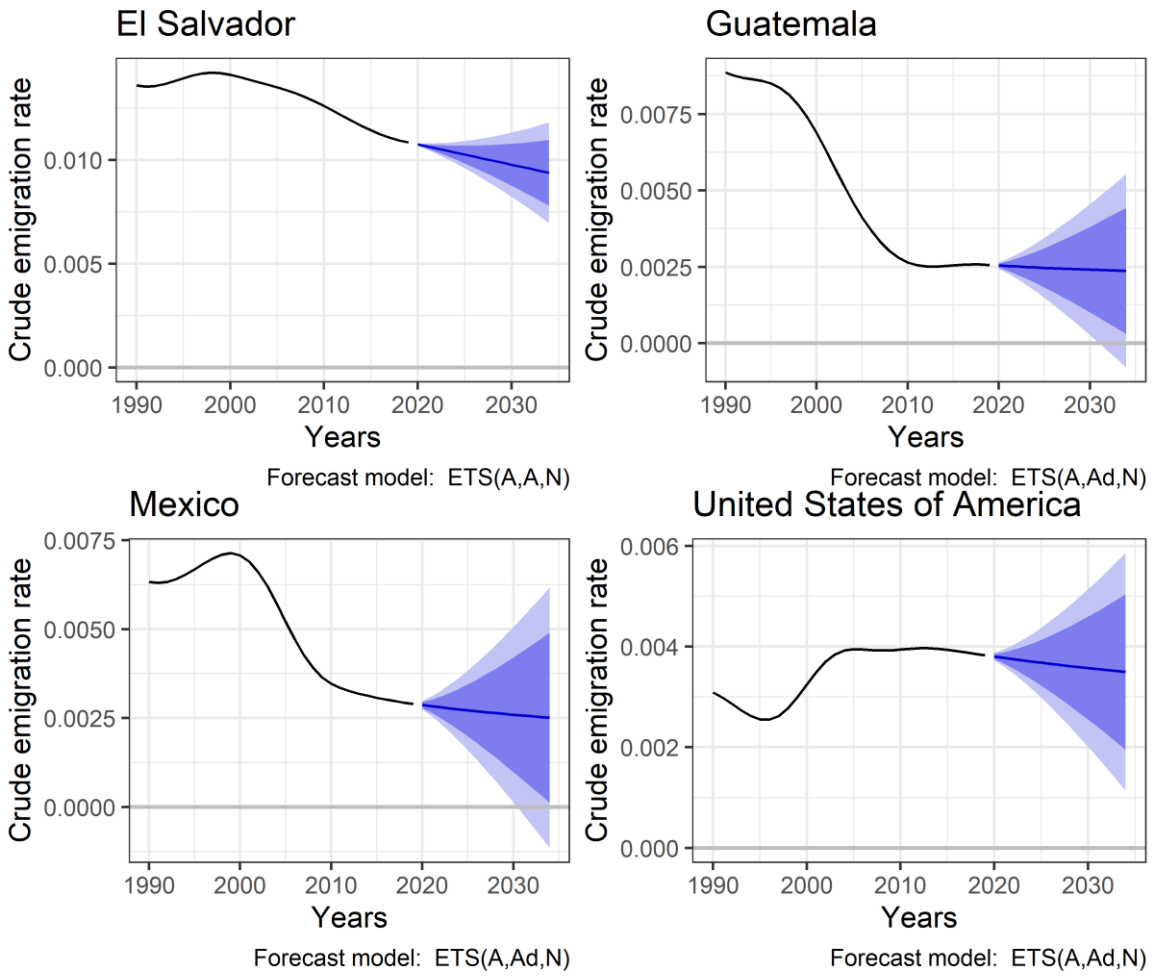


Figure 40: Crude Total Emigration Rates 1990-2035 by Country, Corridor 1



7.5 Codes of Exponential Smoothing Methods

Table 23: ETS classification codes

Trend	Seasonality		
	N (None)	**A** (Additive)	**M** (Multiplicative)
N	(N, N)	(N, A)	(N, M
A	(A, N)	(A, A)	(A, M)
Ad (damped)	(Ad, N)	(Ad, A)	(Ad, M)

Original method name

Code	Method
(N, N)	Simple exponential smoothing
(A, N)	Holt's linear method
(Ad, N)	Additive damped trend method
(A, A)	Additive Holt-Winters' method
(A, M)	Multiplicative Holt-Winters' method
(Ad, M)	Holt-Winters' damped method

7.6 Glossary

Table 24: Abbreviations

Abbreviation	Category
	Development status (UN)
LDR	Less Developed Region
LDC	Least Developed Country
LLDC	Land-Locked Developing Countries
	Income status (WB)
MIC	Middle-Income Countries
LIC	Low-Income Countries
Source:	United Nations, Department of Economic and Social Affairs, Population Division: World Population Prospects Database extract. 6/13/2021 3:59:57 PM.

8 References

Abel, Guy. 2009. “International Migration Flow Table Estimation (PhD).” PhD Thesis, Southampton: University of Southampton.

———. 2017. “Estimates of Global Bilateral Migration Flows by Gender Between 1960 and 2015.” *International Migration Review*, November, 1–44. https://doi.org/10.1111/imre.12327.

———. 2021. “Bilateral International Migration Flow Estimates for 200 Countries.” https://guyabel.com/publication/bilateral-international-migration-flow-estimates/.

Abel, Guy J., Jack DeWaard, Jasmine Trang Ha, and Zack W Almquist. 2021. “The Form and Evolution of International Migration Networks, 1990–2015.” *Population, Space and Place* 27 (3). https://doi.org/10.1002/psp.2432.

Abel, Guy, and Joel E Cohen. 2019. “Bilateral International Migration Flow Estimates for 200 Countries.” *Scientific Data* 6 (1): 82. https://doi.org/10.1038/s41597-019-0089-3.

Böhme, Marcus H., André Gröger, and Tobias Stöhr. 2020. “Searching for a Better Life: Predicting International Migration with Online Search Keywords.” *Journal of Development Economics* 142 (January): 102347. https://doi.org/10.1016/j.jdeveco.2019.04.002.

Buettner, Thomas. 2021. “World Population Prospects – a Long View.” *Economie Et Statistique / Economics and Statistics*, no. 520-521 (January): 9–27. https://doi.org/10.24187/ecostat.2020.520d.2030.

———. 2022. “Stocktaking of Migration Data.” KNOMAD Paper 42. Washington D.C.: World Bank. https://www.knomad.org/publication/stocktaking-migration-data.

Buettner, Thomas, and Rainer Muenz. 2016. “Comparative Analysis of International Migration in Population Projections.” KNOMAD Working Paper No. 10. World Bank, Washington DC: World Bank. http://www.knomad.org/publication/comparative-analysis-international-migration-population-projections.

———. 2018a. “International Migration Projections: Methodology Brief.” KNOMAD WORKING PAPER 30 - Annex. Washington, D.C. http://www.knomad.org/publication/international-migration-projections-methodology-brief.

———. 2018b. “Modeling Alternative Projections of International Migration.” KNOMAD Working Paper No. 30. Washington, DC: World Bank. http://www.knomad.org/publication/modeling-alternative-projections-international-migration.

———. 2020. “Migration Projections: The Economic Case.” KNOMAD PAPER 37. Washington, D.C.: World Bank. https://www.knomad.org/publication/migration-projections-economic-case.

Fagiolo, Giorgio, and Marina Mastrorillo. 2013. “International Migration Network: Topology and Modeling.” *Physical Review E* 88 (1): 012812. https://doi.org/10.1103/PhysRevE.88.012812.

Hyndman, Rob J, and G Athanasopoulos. 2021. “Forecasting: Principles and Practice.” OTexts. https://otexts.com/fpp3/.

Hyndman, Rob J, and Yeasmin Khandakar. 2008. “Automatic Time Series Forecasting: The Forecast Package for r.” *Journal of Statistical Software* 27 (3): 22. https://doi.org/10.18637/jss.v027.i03.

IOM. 2019. *World Migration Report 2020*.

Jenks, G F. 1977. *Optimal Data Classification for Choropleth Maps*. Occasional Paper. University of Kansas, Department of Geography.

Jenks, George F. 1963. “Generalization in Statistical Mapping.” *Annals of the Association of American Geographers* 53 (1): 15–26. https://doi.org/10.1111/j.1467-8306.1963.tb00429.x.

Köppen, Bernhard, Thomas Buettner, and Rainer Muenz. 2022. “Review of Global Flow Estimates and the Identification of Migration Corridors.” KNOMAD PAPER Nn. Washington D.C.: World Bank.

R Core Team. 2021. *R: A Language and Environment for Statistical Computing*. Vienna, Austria: R Foundation for Statistical Computing.

Rikani, Albano, and Jacob Schewe. 2021. “Global Bilateral Migration Projections Accounting for Diasporas, Transit and Return Flows, and Poverty Constraints.” *Demographic Research* 45 (July): 87–140. https://doi.org/10.4054/DemRes.2021.45.4.

RStudio Team. 2022. *RStudio: Integrated Development Environment for r*. Boston, MA: RStudio, Inc.

Siegel, Jacob S, and David A Swanson. 2004. *The Methods and Materials of Demography*. Edited by Jacob S Siegel and David A Swanson. Amsterdam; Boston: Elsevier Academic Press.

Stillwell, John, Martin Bell, Marcus Blake, Oliver Duke-Williams, and Philip Rees. 2000. “Net Migration and Migration Effectiveness: A Comparison Between Australia and the United Kingdom, 1976–96 Part 1: Total Migration Patterns.” *Journal of the Australian Population Association* 17 (1): 17–38. https://doi.org/10.1007/BF03029446.

United Nations. 1970. “Manual VI: Methods of Measuring Internal Migration.” Population Studies. New York: Department of Economic; Social Affairs, Population Division.

———. 2019. *World Population Prospects 2019, Volume i: Comprehensive Tables*. Vol. I.

———. 2020. “International Migrant Stock 2020.” United Nations Database, POP/DB/MIG/Stock/Rev.2020. New York: Department of Economic; Social Affairs. Population Division.

Willekens, Frans. 2008. “Models of Migration: Observations and Judgments.” In *International Migration in Europe: Data, Models and Estimates*, edited by James Raymer and Frans Willekens, 117–47. Chichester, England: John Wiley & Sons, Ltd.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