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The estimation of age and sex profiles for international migration amongst countries in the Asia-Pacific region

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Abstract

Information on the age and sex patterns of international migration occurring amongst countries in the Asia-Pacific region is important for researchers and policymakers to understand the contributions of migration towards demographic, economic and social changes. However, despite its importance, statistics on the age and sex patterns are largely absent and, where they do exist, there are considerable differences in measurement and data collection procedures. In this study, we develop a methodology for indirectly estimating the age and sex patterns of international migration for 53 populations in the Asia-Pacific region and four macroworld regions. Multiplicative component models are used to systematically combine information from multiple data sources and infer missing data, resulting in complete and harmonised tables of migration by origin, destination, age, and sex from 2000 to 2019. The estimates are presented and assessed with some discussions on how they may be applied and further improved.

KEYWORDS

age patterns, Asia-Pacific, data integration, international migration, multiplicative component model

1 | INTRODUCTION

Data on international migration are necessary for understanding the demographic, economic and social changes that are occurring in the Asia-Pacific region. This includes, for example, population growth, employment, educational obtainment and social cohesion amongst immigrant groups. Evidence from census information on migrant population stock suggests international migration is increasing in the region and becoming more influential as a factor of change (Charles-Edwards et al., 2016; De Haas et al., 2020). However, without actual and accurate statistics on the movements, it is difficult to understand what is driving the change or even how many persons are migrating across countries in any given year. This absence of information greatly hinders policy formation and planning by government agencies in the region (Huguet, 2008).

Knowing how many people are emigrating or immigrating each year is a starting point for understanding the mechanisms of migration. Following this, details are needed on the origins, destinations, ages and sex of migrants. Together, these characteristics provide the basis for understanding both the motives and consequences of migration. In this paper, we focus on estimating the age and sex patterns of migration in the Asia-Pacific region from 2000 to 2019, and show how they can be integrated with an auxiliary data set of bilateral migration flows.

Age patterns of international migration represent an important aspect of demographic study (Castro & Rogers, 1983). They describe, for example, the ages of those migrating for education, participation in the labour force, family reunification and return to their countries of origin. They can also be linked to various life course stages that influence migration (Bernard et al., 2014a; Willekens, 1999) or to specific visa pathways that countries provide for education, work or reunion with family (Raymer et al., 2019). Finally, age patterns of migration can be used to study the impacts on the age composition of the receiving population. Here, immigration usually affects population age compositions by adding young adults to the working age population and through childbearing.

Migration by sex is another fundamental characteristic that is required for measuring demographic change and for assessing the drivers, vulnerabilities and needs of migrants. Migration by sex differs depending on the types of employment or education migrants seeking or being qualified to obtain. Calls for 'orderly, safe, regular and responsible' migration is included in the United Nations' 2030 Agenda for Sustainable Development (United Nations, 2022) with Goal 5 targeted towards obtaining gender equality and Goal 10 on reducing inequality within and amongst countries. Ensuring migrants are not disadvantaged is considered an important aspect of the Goals. Females in particular are considered highly vulnerable to labour market exploitation (De Haas et al., 2020) and, thus, information is needed on their migration patterns relative to their male counterparts. Moreover, flows of migration often include partners, parents and children of migrants, each with their own specific needs.

Our aim in this paper is to gain a better understanding of the age and sex patterns of migration in the Asia-Pacific region. As this information is largely absent from national statistical offices, we develop a methodology to add age and sex information to a recently estimated series of bilateral (origin–destination) flows of international migration (Raymer et al., 2022). In our study, the Asia-Pacific region is comprised of 53 countries and areas (countries hereafter). A list of the countries is provided in Appendix A (Table A1). The list includes countries in Eastern (E) Asia, South-eastern (S-E) Asia, Southern (S) Asia, Oceania and Northern (N) America according to the United Nation's Standard Country or Area Codes for Statistical Use (United Nations, 2011). Other Asia countries located away from the Pacific Rim are grouped in a Rest of Asia (ROA) region. The three other macroworld regions (ROWs) are: Europe, Africa, and South and Central America.

This research is important for understanding the migration that is occurring in the Asia-Pacific region and for overcoming data issues concerning the measurement of migration flows. Age- and sex-specific flows are needed for many things, not the least understanding the dynamic nature of migration, the sources and destinations of migration, and as inputs into models for population change and policies concerning the wellbeing of migrants. This work adds to research efforts aiming at indirectly estimating migration flows by age or sex with a focus on annual flows, measured in line with the United Nations' (1998, 2020b) recommendations and could be used as inputs into regional or country-level population projections. The model framework is also flexible and can be updated or expanded when new sets of information and data become available.

2 | BACKGROUND

Asia-Pacific is a large and heterogeneous region consisting of 53 countries (see Table A1). Population sizes of countries in this region in 2019 ranged from approximately 1000 persons in Tokelau to 1.4 billion persons in China. According to the United Nations (2019a) International Migrant Stock Database, China and India had the largest numbers of migrants living abroad in 2019 (4.2 million persons and 6.6 million persons, respectively), while the United States, Canada and Australia had the largest numbers of migrant populations living (50.7 million, 8.0 million and 7.5 million, respectively).

Understanding international migration within the Asia-Pacific region, as well as from and to other regions in the world, is needed to understand global migration patterns. Most of what we know about global migration is based on migrant population stock data from censuses gathered once every 5 or 10 years and flow statistics from major receiving countries consisting primarily of countries located in Europe, North America and Oceania. Due to the population size of the Asia-Pacific region alone, changes in international migration within, from and to the region are likely to have great implications outside the region. Asia-Pacific's total population in 2019 was 4.7 billion out of the world's total population of 7.7 billion. According to the United Nations (2019a) International Migrant Stock Database, there were 47.5 million migrants (58%) originating from the Asia-Pacific within the region and 34.5 million migrants (42%) outside the region.

The Asia-Pacific region is undergoing rapid economic development with many countries already considered highly developed both economically and demographically (i.e., low fertility/high longevity). Migration transition theory (De Haas et al., 2020; Zelinsky, 1971) based on European experiences posits that as countries economically develop, they experience increased emigration which gradually decreases to the point where it becomes lower than immigration. That is, to maintain economic development of a country, immigration becomes increasingly important by bringing in both high-skilled and low-skilled labour. Whether all countries in the Asia-Pacific region, including very large ones like China and India, will soon be recruiting large numbers of immigrants to support their growing economies and ageing populations is unknown and debatable. Certainly, we have witnessed increased immigration associated with economic development in Malaysia, Thailand, Singapore, Japan and South Korea (Amrith, 2018). There remain many large populations in the region, such as Bangladesh, Indonesia, the Philippines and Vietnam, where high levels of migration are expected to continue or even increase due to projected population growth and economic development (De Haas et al., 2020; Fong & Shibuya, 2020). Also important are the small island populations that are geographically isolated and under threat from climate change. Understanding the role of migration for these small countries is critical for both their economic development and potential plans for permanent emigration. At present, due to the absence of data, we know very little about their migration networks and how they are evolving over time (Guan et al., 2022).

Motivations of migrants at different ages can be understood in relation to life course transitions, such as leaving the parental home, seeking education or employment, marriage or divorce, seeking a better environment, joining family members and friends, and returning after education or completing a job (Bernard et al., 2014b; Rogers & Castro, 1981). Different manifestations of migration age (and sex) profiles are due to differences in the dominating reasons for migration. Indeed, typologies of migration age profiles associated with moves for higher education, employment and retirement have been developed for internal migration in the United States (Plane & Heins, 2003). Similarly, Raymer et al. (2019) showed how employment, education and family reunification visas characterised immigration and emigration age profiles for Australia.

Rogers and Castro (1981) model migration schedule is the most well-known and widely applied parametric model used to infer migration age profiles. Model migration schedules may be used to infer the entire or missing age patterns and to smooth migration age profiles. Alternatively, log-linear models may also be used to infer detailed age and sex patterns of migration (Rogers et al., 2010). This takes a categorical data analysis perspective, where the age–sex patterns come from higher order marginal structures. For example, the age and sex characteristics of a specific origin–destination flow may be inferred from the age and/or sex structure of the origin's total outflow and the destination's total inflow. Statistical analysis has shown that this model tends to perform well overall. International migration examples of applying this approach include Raymer et al. (2011) and Wiśniowski et al. (2016)—both were applied to model the age and sex patterns of international migration amongst European Union and European Free Trade Association countries.

Depending on the context, migration by sex can vary considerably. For example, recent migrants from China to Australia involve more females than males but, interestingly, China-born emigrants from Australia are dominated by males (Raymer et al., 2020). In general, male-dominated flows tend to be associated with low-skilled construction and manual labour, whereas female-dominated flows tend to be associated with education and low-skilled domestic work (De Haas et al., 2020, pp. 289–290; UNDESA, 2006, pp. 30–34). Finally, it is important to remember that migration may consist of whole families or family members joining previous migrants. In some cases, parents may join their children to assist with childcare of their grandchildren or for care support in their old age (King et al., 2014; Ryan et al., 2009).

Recently, the 'flow from stock' model developed by Abel and Sander (2014) has been extended to include sex profiles of international migration (Abel, 2018; Abel & Cohen, 2022). Migration flows are inferred based on reported migrant population changes, taking into account the demographic influences of fertility and mortality. The main issue concerning this method is that it captures only the minimum transitions necessary to explain the differences in stocks over a 5-year period. It does not capture the number of persons migrating during a particular period of time. Also, since the method relies on data defining migrants by country of birth or citizenship, it does not fully capture return flows. Azose and Raftery (2019) partially addressed this issue by integrating estimates from the Integrated Modelling of European Migration (IMEM) project (Raymer et al., 2013), but due to the lack of data outside Europe, it was not effective in estimating flows from and to countries in Asia, Africa and South America. Our approach, on the other hand, focuses on estimating the number of persons migrating across countries in the Asia-Pacific region. These numbers (or migration events) capture the patterns of movements over time and represent the basic inputs needed in most demographic projections, alongside birth and death events (Rees, 1985).

3 | DATA

As identified in many studies, data paucity and inconsistency are major challenges for research on migration and its impacts (Bilsborrow et al., 1997; De Beer et al., 2010; Kelly, 1987; Kupiszewska & Nowok, 2008; Willekens et al., 2016). Most of the data we draw from are estimated values paired with limited information on migration age and/or sex patterns obtained from a few national statistical offices. The first source of information is a set of estimated origin-destination annual migration flows amongst 53 Asia-Pacific populations and four macro world regions between 2000 and 2019 (Raymer et al., 2022).

The second source of information is the 2020 International Migrant Stock Database (United Nations, 2020a), which represents age- and sex-specific migrant population stocks for 52 Asia-Pacific countries/areas (excluding Taiwan) every 5 years from 1990 to 2020. For almost all countries, migrant population stock is the only source of international migration information. Migrant population stocks are usually defined by country of birth; however, 14 of the Asia-Pacific countries define their migrant population stocks by country of citizenship. In this paper, we assume the two definitions reflect similar patterns and treat them without distinction (a similar approach was taken by Özden et al., 2011). The age and sex profiles of migrant population stocks for 12 selected countries are presented in Figure 1 (5-year age groups are used).

The third source of information is the migration flow estimates produced by Abel and Cohen (2022). Abel and Cohen's paper estimates six sets of origin-, destination- and sex-specific migrant flows from 1990–1995 to 2015–2020. We use the results from the Pseudo-Bayesian demographic accounting method (Azose & Raftery, 2019) as it was found to perform better than other methods. This method is based on quinquennial migrant population stocks (United Nations, 2015) from 1960 to 2015, controlling for demographic changes in the destination countries and distances between origins and destinations with weights estimated by Azose and Raftery (2019). These estimates are described as 5-year minimum migrant transitions resulting in the change in reported migrant population stocks over five.

Finally, reported migration flow data from Organization for Economic Co-operation and Development (OECD) countries in the Asia-Pacific region are used to provide baseline age-sex profiles. Specifically, we use the counts of long-term immigration and emigration from 2000 to 2019 published by the Australian Bureau of Statistics, (2016, 2021), Statistics Korea (2022), Statistics New

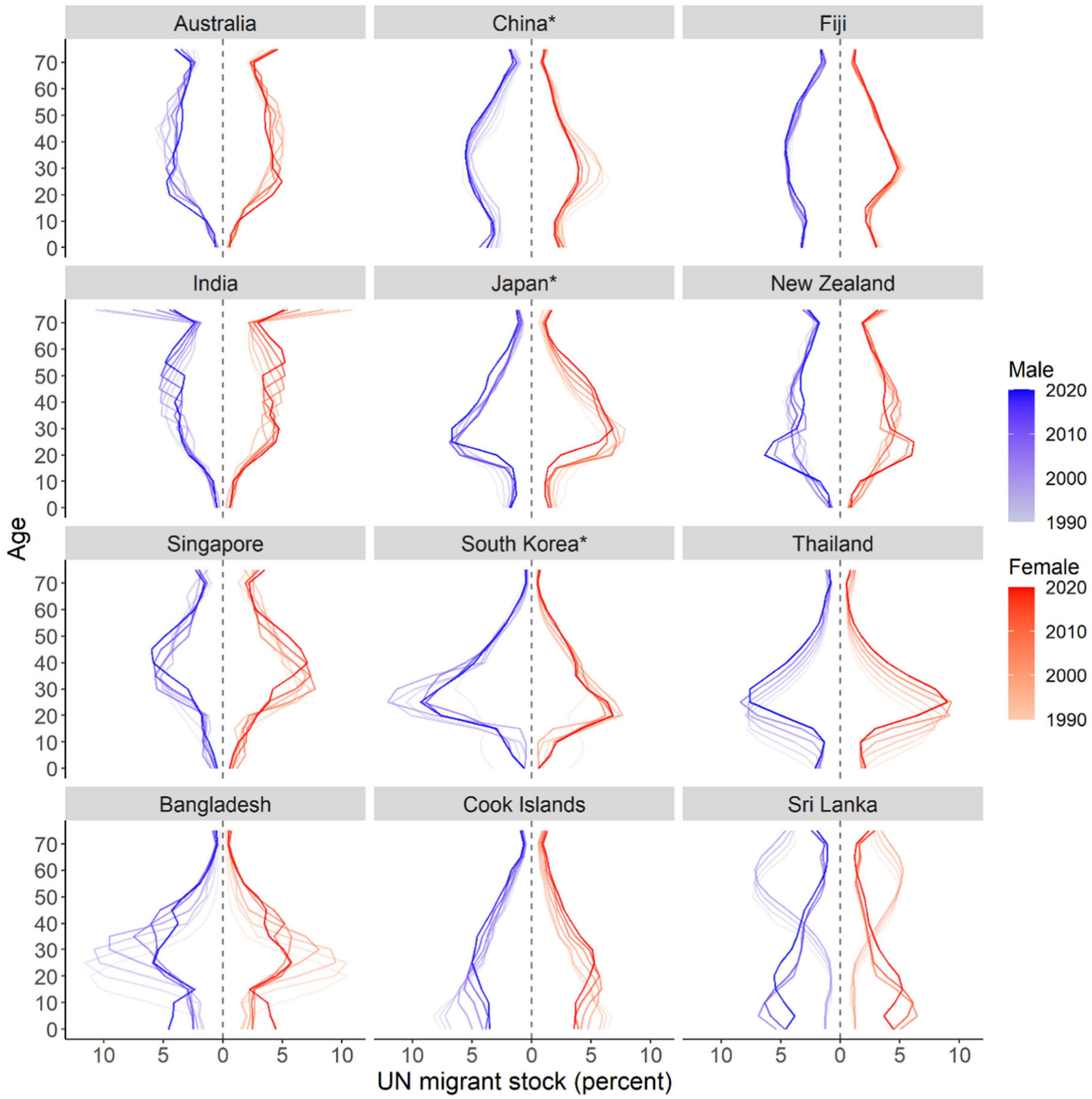

FIGURE 1 Migrant population stocks by age, sex and year for 12 selected countries, 1990–2020. Country with asterisks use foreign citizenship to define migrants; all other countries use foreign birthplace to define migrants. *Source*: United Nations (2020a).

Zealand (2021) and Statistics Canada (2022). We also use the age- and sex-specific numbers of Japanese who returned to and stayed in Japan for at least 1 year (Statistics of Japan, 2021). The OECD (2020) International Migration Database also includes some information on the origin of foreign immigrants and the destination of foreign emigrants by sex. However, the definition of foreign immigrants varies by country with some using the country of birth definition and others using the country of citizenship or residency.

The International Labour Migration Statistics (ILMS) Database (International Labour Organization, 2018) has some information on the sex of labour migrants in Association of Southeast Asian Nations (ASEAN) countries. However, these data are not used as model inputs because several types of migrants are missing in ILMS. These include returning nationals, family migrants and education migrants, who may have very different sex profiles compared to labour migrants.

4 | METHODOLOGY

The main issue concerning the study of age and sex patterns of migration in the Asia-Pacific region is the near complete absence of data. This paper adopts the multiplicative component method proposed by Van Imhoff et al. (2011; see also Van Imhoff et al., 1997) to disaggregate origin-destination flows by age and sex. As in our situation, the method starts from a complete origin by destination (OD) two-way migration flow table produced in Raymer et al. (2022). The multiplicative model has two main effects, (O_i) and (D_j), and one interaction effect, (OD_{ij}), specified as

$$n_{ij} = (T)(O_i)(D_j)(OD_{ij}), \tag{1}$$

where n_{ij} is the observed flow (counts) of migrants from origin i to destination j and (T) is the overall migration level. Age and sex information are then incorporated by expanding the multiplicative component model to include all age and sex effects to represent a saturated ODAS four-way (origin by destination by age by sex) table, that is,

$$n_{ijxy} = (T)(O_i)(D_j)(A_x)(S_y)(OD_{ij})(OA_{ix})(OS_{iy})(DA_{jx})(DS_{jy})(AS_{xy}) (ODA_{ijx})(ODS_{ijy})(OAS_{ixy})(DAS_{jxy})(ODAS_{ijxy}). \quad (2)$$

where n_{ijxy} is the flow (counts) of migrants of sex y migrating from origin i to destination j at age x. (A_x) is the main age effect. (S_y) is the main sex effect. There are five two-way interaction effects, (OD_{ij}), (OA_{ix}), (OS_{iy}), (DA_{jx}), (DS_{jy}) and (AS_{xy}); four three-way interaction effects, (ODA_{ijx}), (ODS_{ijy}), (OAS_{ixy}) and (DAS_{jxy}); and one four-way interaction effect $(ODAS_{ijxy})$.

With no other set of complete migration flow data available, we assume that recently produced origin-destination flow estimates from Raymer et al. (2022) are true. These estimates represent annual events in line with the United Nations (1998) recommendations for measurement of international migration. However, data on Asia-Pacific migration age and sex profiles are extremely sparse. Thus, it is not possible to fit the saturated model specified in Equation (2). Instead, we fit an unsaturated model representing a reduced form of the model. This model is specified as

$$\hat{n}_{ijxy} = (T)(O_i)(D_j)(A_x)(S_y)(OD_{ij})(OS_{iy})(DA_{jx})(DS_{jy})(AS_{xy})(DAS_{jxy}). \quad (3)$$

The unsaturated model omits the complex three- and four-way interactions terms, except for destination–age–sex, DAS_{jxy}. The choice of model components is based on data availability and, as we demonstrate below, the model's ability to capture key age and sex patterns of origin–destination–specific migration flows. The model is conceptualised within a log-linear modelling framework but uses iterative proportional fitting (IPF) to estimate the migration counts. IPF is useful for combining information from multiple categorical tables (Lomax & Norman, 2016; Van Imhoff et al., 1997). The estimates can also be constrained to specific marginal totals. The estimates produced using IPF are the same as those produced using log-linear with offset models. However, IPF does not estimate model parameters.

In Figure 2, we present our model framework. There are four stages in the model. Each stage incorporates new information into the unsaturated model (Equation 3) and generates a set of stand-alone estimates that can be assessed. For illustration, we present changes in hypothetical migration age and sex profiles in Figure 2 to demonstrate the effects of adding or modifying multiplicative components at each stage. Flows are not estimated for the diagonal elements nor between the four ROWs. In Table B1, a summary of the modelling procedures for each stage and the data involved is provided.

Stage 1 of the model involves estimating an overall age schedule for each sex (the yellow-shaded cell in Figure 2), producing the same age–sex patterns for every OD flow. Stage 2 modifies the age and sex schedule estimated in Stage 1 for each destination (the green cells in Figure 2, Stage 2). Through this process, the overall sex ratio is revised based on the new destination-specific information (shaded blue in Figure 2, Stage 2). Stage 3 adds sex ratio information for each origin and the four ROW destinations (the orange cells in Figure 2, Stage 3). The overall sex ratio S_y is, again, revised. Finally, in Stage 4, the estimates are adjusted to coincide with available reported data (shaded brown in Figure 2, Stage 4). The general modelling framework allows the estimation of age- and sex-specific OD flows to be systematically refined and improved using auxiliary information. In the sections below, we describe the main procedures in each stage. For more technical details, refer to Supporting Information: 1.

4.1 | Stage 1: Adding overall age and sex profiles

The goal of Stage 1 is to impose sex-specific age profiles to all flows in the estimated OD table over time. The model for this stage of the modelling process is specified as

$$n^{I}_{ijxy} = (T)(O_i)(D_j)(A_x)(S_y)(OD_{ij})(AS_{xy}). \quad (4)$$

IPF (Lomax & Norman, 2016) is used to impose the same age–sex schedule for all origin-destination flows (cf. Figure 2) with the constraint that each origin-destination total flow (summed across age and sex) must equal the corresponding original estimated origin–destination flow. Age is represented by 5-year age groups, that is, 0–4 years, 5–9 years, …, 85+ years. Information on the overall age schedule is based on reported statistics from Australia, Canada, South Korea and New Zealand. To include uncertainty in our estimates, we apply a nonparametric technique of random subsampling (Efron, 1981) that first removes 20% of the available data at random to produce a subset of observed migrant proportion by age groups. With this subset of data, we use Locally Weighted Scatterplot Smoothing (or LOESS regression) to fit a smoothed curve to the migration proportions by age and sex. This nonparametric technique combines aspects of weighted moving average smoothing with weighted linear or polynomial regression (Cleveland, 1979; Cleveland & Devlin, 1988; Harrell, 2001, pp. 24–25). The overall sex effect, S_y, is set to 0.5 for both males and females. The age–sex interaction effect, AS_{xy}, contains the ratios of male to female migrants for each age group. The median of estimated proportions of migrants by age and sex are presented in Figure 3 with 80% prediction intervals. After smoothing by LOESS regression, the age profiles appear to be not sensitive to the change in input data as 1000 iterations did not produce any noticeable uncertainty.

Finally, random subsampling of the age-sex profiles is coupled together with sampling from the uncertainty measures of the OD flows (Raymer et al., 2022). This introduces an additional source of uncertainty to the resulting age and sex profiles described above. Therefore, the total uncertainty resulting from this stage incorporates the uncertainty from the age- and sex-specific estimation process through resampling and the uncertainty from the existing OD estimates.

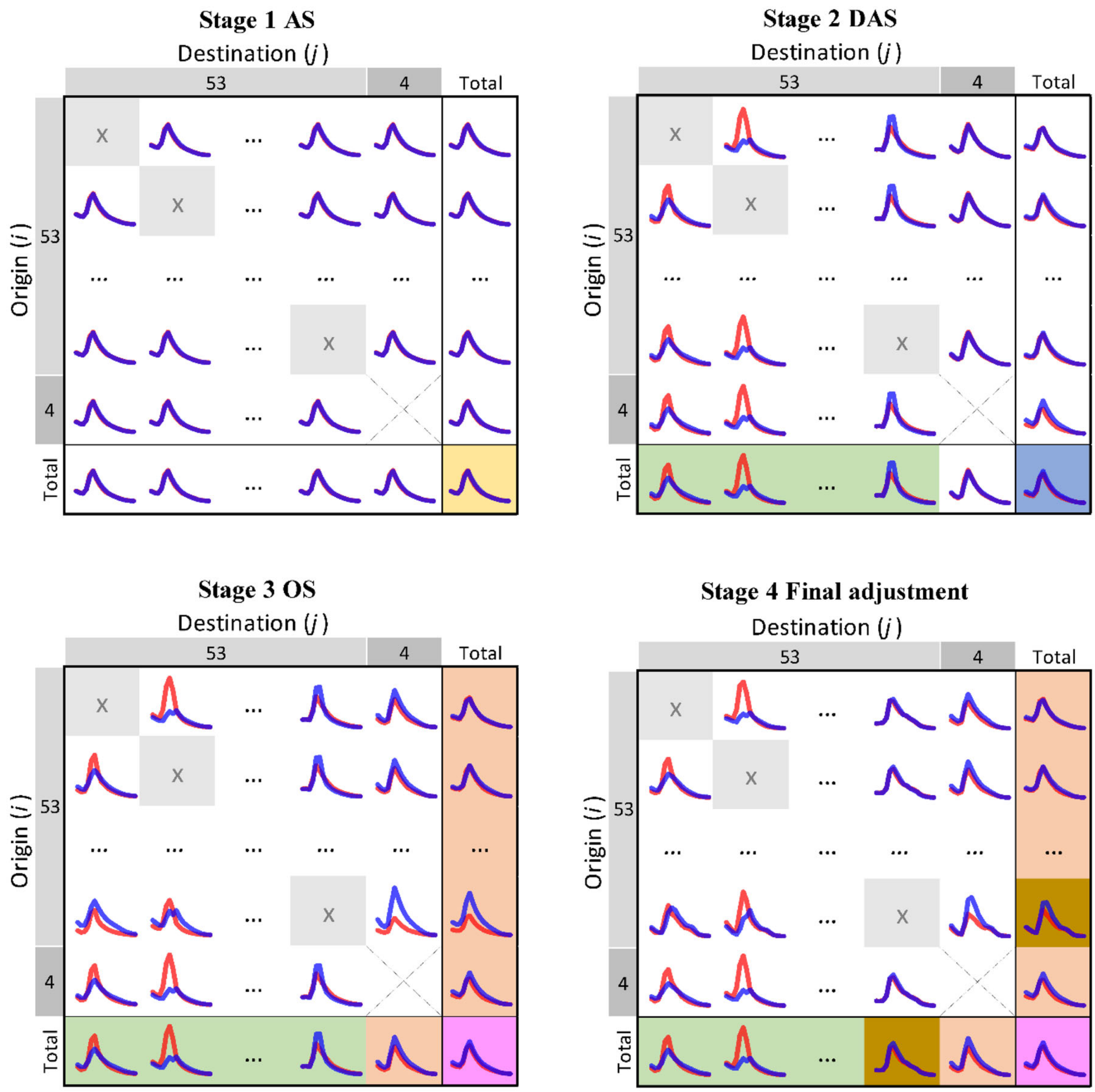

FIGURE 2 Four-stage estimation process for disaggregating origin-destination flows by age and sex. The lines in each cell are schedules of migration flow by age and sex (not to scale). Blue lines represent male and red lines represent female. The shaded cells are adjustments incorporated in each stage. Flows are not estimated for the diagonal elements nor between the four macroworld regions (ROWs).

4.2 | Stage 2: Adding age and sex details for each destination

The goal of Stage 2 is to model the age and sex profile for each destination (i.e., immigration flows by age and sex). The model for this stage of the modelling process is specified as

$$n^{II}_{ijxy} = (T)(O_i)(D_j)(A_x)(S_y)(OD_{ij})(DS_{jy})(AS_{xy})(DAS_{jxy}). \quad (5)$$

At this stage, we revise S_y and AS_{xy}, and produce DA_{jx}, DS_{jy} and DAS_{jxy}. The sex main effect, S_y, derived from DAS_{jxy}, replaces the naïve sex ratio assumed in Stage 1.

Migrants arriving in a country can be native-born/nationals (hereinafter nationals) or foreign-born/foreigners (hereinafter foreigners) with the age and sex distribution for these two groups likely being different. For example, about 40% of foreigners who arrived in South Korea between 2000 and 2018 were female, whereas more than 50% of the nationals who returned to South Korea were female. Therefore, we separate our estimation of immigration flows by age by sex (DAS) for nationals and foreigners. The two are then combined using weights to obtain the complete DAS table.

In Stage 2a, we estimate the DAS table for foreigners based on information from the United Nations' International Migrant Stock Database. These data represent migrant population stocks. As illustrated in Figure 1, the majority of the migrant population stocks in the Asia-Pacific region are comprised of young adults. Major migration destination countries, such as Australia, contain both recent and earlier arrivals as migrants ageing in the destination

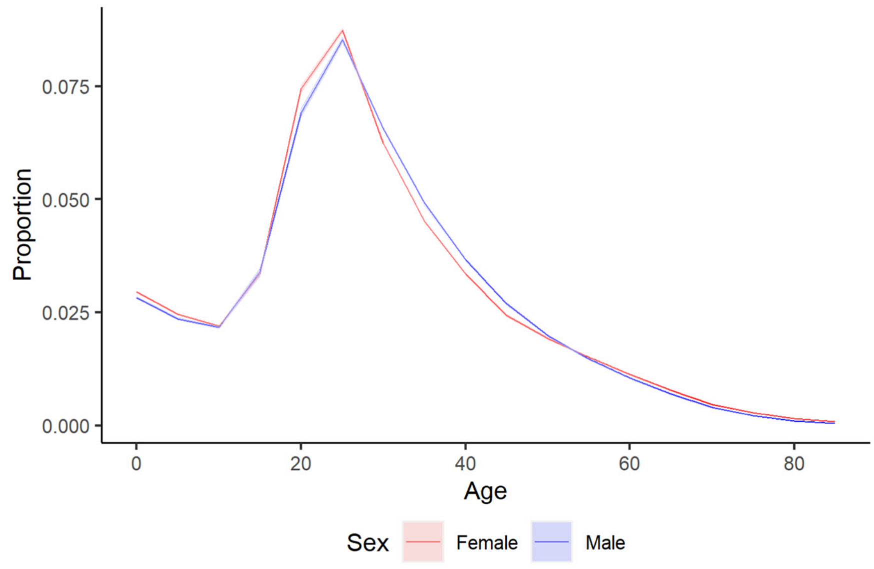

FIGURE 3 Estimated median age and sex profiles migration in the Asia Pacific region. Line represents the median estimates with a relatively narrow 80% predictive interval. *Sources*: Authors' calculations based on Australian Bureau of Statistics (2021), Statistics Canada (2022), Statistics Korea (2022) and Statistics New Zealand (2021).

country. Singapore and Thailand's age profiles also demonstrate the ageing of earlier arrivals, where the peaks of their age profiles shift older over time. Some countries, such as Bangladesh, Sri Lanka and Cook Islands, show peculiar age profiles in their migrant population stocks. Their age profiles shift quite substantially over time, likely due to large and sudden changes in the migrant population stock or poor data quality.

As we are unable to use the age and sex information directly, we transform the migrant population stocks into changes in stock to simulate net transition measures. The changes in stock are estimated with a reverse cohort component method that projects backwards the migrant population stocks in 5-year intervals, adjusting for survivorship of the populations (see Supporting Information: 1). The difference between the back projection value and the actual stock is the change in stock and is based on the assumption that no one emigrates. Thus, the change in stock represents a minimum transition between two time points of two subsequent age groups. Further, as this transition can take place in the younger age-period-cohort between two time points (or younger age group) or the older age-period-cohort (or older age group), we assign a uniform distribution to divide the change in stock into two age groups randomly. A Lexis diagram is presented in Supporting Information: 1—Figure S2 to illustrate the entering ages from a cohort perspective. As in Stage 1, a thousand iterations are performed, where each iteration draws from the uniform probability distribution that is used to distribute transition to a younger or older age group.

In the calculation of net transitions, we have not included migrant population stocks for ages 0–4 years old. The reason is that the reported migrant population stocks are not comparable with the changes in stock calculated using the cohort method. Moreover, the migrant population stocks only provide information until age 70–74 years, but our estimates extend age groups to 85+ years. Inspired by Rogers and Castro (1981), we fit a negative exponential curve to the second half of the labour force peak (i.e., downward-sloping half) and replace the estimated values with the smoothed values for age groups above 25, 30 or 35 years old depending on the sum of square error between the smooth curve and the estimated one.

The age and sex profiles for the returning nationals are estimated separately (Stage 2b; see also Supporting Information: 1). To the best of our knowledge, only three countries in the Asia-Pacific region had detailed flow statistics by age and sex on immigration of the local-born (Australia) or national citizens (South Korea and Japan). Age profiles for returning nationals are estimated by LOESS regression to smooth the age distributions of returning nationals by sex similar to the same method as in Stage 1. For the sex ratios of returning nationals by country, we use information from the OECD (2020) International Migration Database on the emigration of foreigners by sex and birthplace/nationality from Australia, South Korea and New Zealand. Assuming that foreign emigrants return to their country of citizenship or birthplace in similar proportions by sex, we use the sex ratio of foreigner outflow to a certain country as a proxy for the sex ratio of the returning nationals to that country.

With the age and sex profiles of foreigner and national immigrants estimated for each destination, the next step (Stage 2c; see also Supporting Information: 1) involves combining them together to produce the DAS table and then update the Stage 1 estimates. To obtain the combined profile, the proportion of returning nationals amongst all immigrants is needed. Intuitively, major receiving countries would have more foreigners arriving, while major sending countries would expect more nationals returning. We model the relative weights based on a fractional logistic regression between reported proportions of nationals (for Australia, South Korea and New Zealand) and three migration indices measuring the impact and intensity of migration (i.e., net migration rate, migration efficiency and percentage migrant population). With the estimated parameters of the fractional logistic regression, we are able to calculate the proportions of returning nationals for each of the 53 destinations (see Supporting Information: 1—Figure S6).

The foreigner and national DAS tables are combined by applying the estimated proportions (weights) for each country. At the end of Stage 2, we revise or produce the following interaction terms: S_y, AS_{xy}, DA_{jx}, DS_{jy} and DAS_{jxy}.

4.3 | Stage 3: Adding sex details for each origin and the ROW region destinations

Stage 3 is designed to add origin–sex interactions, OS_{iy}, to all 57 populations (53 Asia-Pacific countries and 4 ROWs) and destination–sex interactions, DS_{jy}, for the four Rest of the World regions. The model for this stage of the modelling process is specified as

$$n^{III}_{ijxy} = (T)(O_i)(D_j)(A_x)(S_y)(OD_{ij})(OS_{iy})(DS_{jy})(AS_{xy})(DAS_{jxy}) \qquad (6)$$

To incorporate OS_{iy} into the model, we use the estimates in Abel and Cohen (2022). Their estimates include 5-year migration transitions by origin, destination and sex from 1990–1995 to 2015–2020 based on six different methods. Since the method using a closed demographic accounting system with a pseudo-Bayesian approach (Azose & Raftery, 2019) produced the highest correlation with reported data, we use this set of estimates to inform our OS_{iy}. However, we only rely on the total estimated levels of immigration and emigration by sex due to the large number of zeros and skewed sex patterns in the origin by destination estimates. For the non-zero flows, over 50% of the origin–destination-specific estimates have one of the sexes accounting for more than 80% of the estimated transitions, which we consider implausible.

In Stage 3a, we focus on estimating the sex ratios for the four ROW destinations (DS_{jy}): Africa, the ROA, Europe, and South and Central America. The sex ratios of immigrants to these destinations are initially set to be 1.0 in Stage 1. To make them vary from 1.0, we combine the sex ratios for total immigration to countries in each ROW region from Abel and Cohen (2022) with the sex ratios estimated in Stage 2. The resulting sex ratios are obtained by using simple weights sampled from a uniform distribution. We choose not to apply the sex ratios from Abel and Cohen's estimates directly due to the presence of extreme sex ratio values. The weighting acts to dampen the extreme sex ratios in their estimates. Since DS_{jy} of other destinations remains the same, the sex main effect, S_y, increases slightly to a median of 1.17 in 2019. We use this value to control for the estimation of OS_{iy} in Stage 3b.

Stage 3b focuses on estimating the origin–sex interaction component, OS_{iy}. We use the sex ratios of total emigration by origin country from Abel and Cohen (2022) and a randomly drawn weight from a uniform distribution to adjust our estimates in Stage 2. As a result, the highest proportion of female emigrants in 2019 is in Mongolia with a median at 0.53 and the lowest in Bhutan at 0.37. A comparison of sex ratios between Stage 3 estimates and Abel and Cohen (2022) by origin or destination is provided in Supporting Information: 1—Figures S7 and S8.

In Figure 4, the estimated proportions of female migrants from Stage 3 are compared with reported proportions from countries with relatively good data, namely Australia, Canada, South Korea and New Zealand. For Australia, Korea and New Zealand, the reported values fall within the 80% prediction interval of the estimated proportion of female immigrants. With regard to the estimated proportions of female emigrants, the estimates are close to the reported values.

The 2019 reported and estimated female and male proportions by age for immigration and emigration to/from Australia, Canada, South Korea and New Zealand are presented in Figure 5. Although the estimates do not always follow the reported data, the peaks and overall trends are reasonably similar. Note that the models produce the age and sex schedules based on very limited data and do not directly use any single country's flows as an input.

4.4 | Stage 4: Final refinements

In the final Stage 4, we replace the estimates for Australia, Canada, South Korea and New Zealand with reported data. IPF is used to maintain the overall age and sex effects in the model. Aside from the four countries above, this final adjustment has only limited effects on Stage 3 estimates.

All calculations are performed using the R Statistical software version 4.2.2 (R Core Team, 2022). The final estimates can be found in Supporting Information: 2 and the online interactive application is available at https://demo268.shinyapps.io/ASAP. The R code with all the estimation procedures and the final estimates with all iterations are available at https://www.doi.org/10.17605/OSF.IO/GJ9FV.

5 | ASSESSING THE RESULTS

In this section, we present the estimates of immigration and emigration flows and validate them against available reported data. Three types of measurements are used to assess the final estimates: migration level, migration age and sex profile and normalised migration intensities. The first one, migration level, is the direct output of the model. In Figure 6, we present our 2019 estimates of immigration by age and sex for a selection of countries with measures of uncertainty. In Figure 7, we compare our immigration and emigration estimates by age (summed across sex) for the same year and set of countries. Since the reported data from Australia, New Zealand and South Korea are used in the Stage 4 of our model, no measures of uncertainty are included. In both cases, we can see that the estimated age patterns vary by country, sex and direction of flow in line with our expectations.

Our results in Figures 6 and 7 show that the largest flows are typically located in the 25-to-29-year-old age group and the smallest flows are in the oldest age groups. This pattern is consistent with the model migration schedule (Rogers & Castro, 1981) and international migration age schedule in Europe (Raymer et al., 2013). Female and male migration flows from and to Oceania or Africa are similar in proportion, while female migration from and to ROA or Southern Asia is substantially smaller than the corresponding male flows. This result is supported by the literature on migration from Southern Asia (India

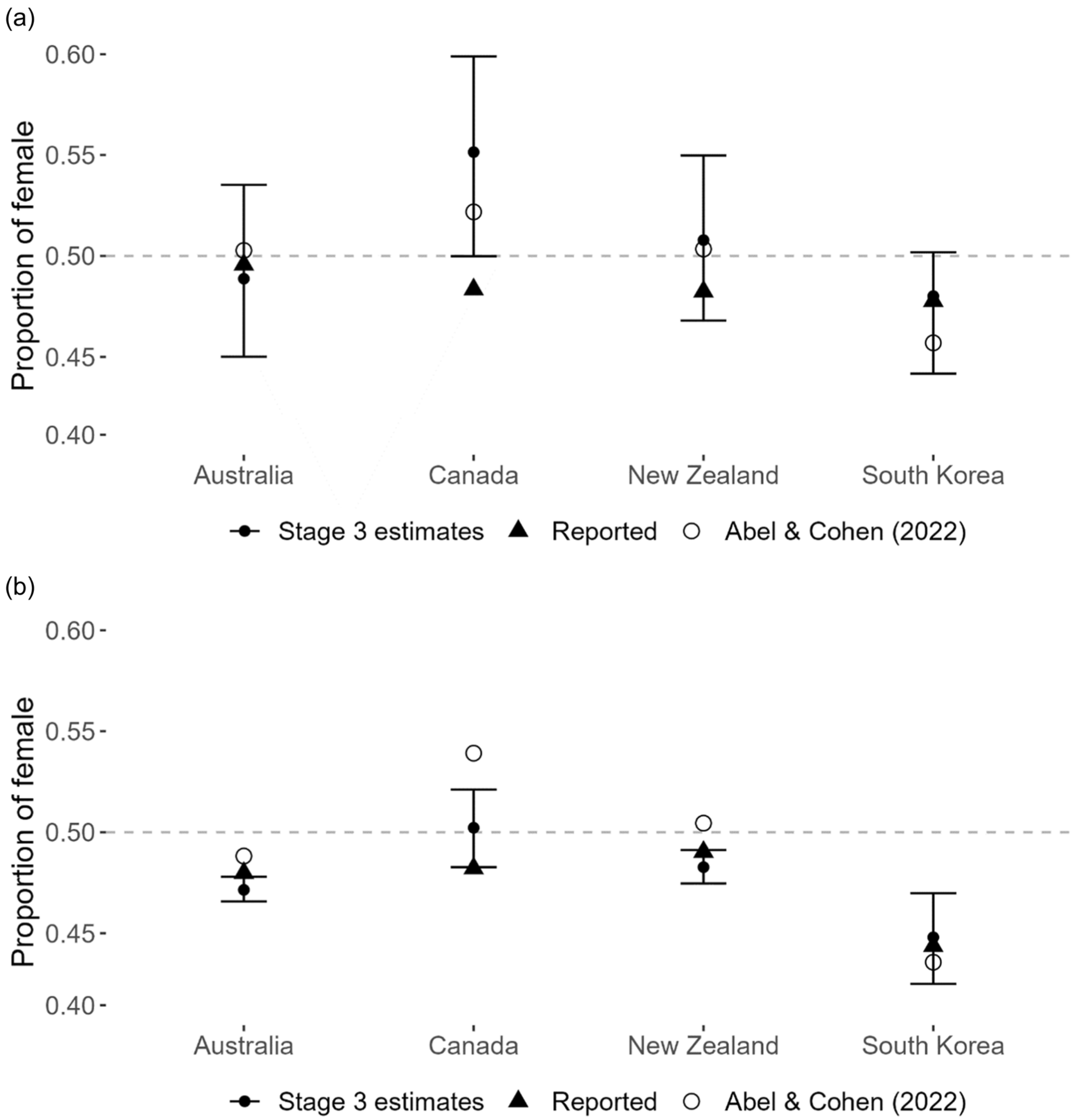

FIGURE 4 Comparison between estimated and reported proportions of females in (a) immigration and (b) emigration flows to and from selected countries, 2019. Abel and Cohen's (2022) estimates are an average of the estimates of Pseudo-Bayesian demographic accounting method across 2000, 2005, 2010 and 2015. The points in the bar represent median estimates. The 80% prediction intervals are the areas between error bars. *Sources*: Author's calculations, Australian Bureau of Statistics (2021), Statistics Canada (2022), Statistics Korea (2022), Statistics New Zealand (2021), Abel and Cohen (2022).

in particular) to the Gulf States where men are recruited for manual labour (Castles et al., 2014; Storbeck, 2011).

The second measurement is the age and sex profile of the migration flow. This approach standardises the age structure and hence can shed light on the different age profiles by sex and directions of flow. The age and sex proportions of immigrants to and emigrants from Australia for nine selected countries in 2013 are presented in Figure 8. At the time of this writing, the Australian Bureau of Statistics (Australian Bureau of Statistics., 2016) only provided data until 2013. The solid lines represent the reported data from the ABS, and the dashed lines are the median estimates with 80% prediction intervals. The uncertainty is relatively small compared to other countries because the total number of immigrants and emigrants by sex and age are replaced by reported values in Stage 4 of the estimation process. Since we are only looking at Australia, the proportion of migrants is the simplest way to compare across migration corridors. The estimates roughly follow the pattern of the reported values, but they do not always capture the sharp labour force peaks. This could be the effect of the overall age effect (A_x), which is a profile with a small peak at the first age group and a broad peak around age 20–30 (Figure 3). Further, the reported migration levels in the first age group are not

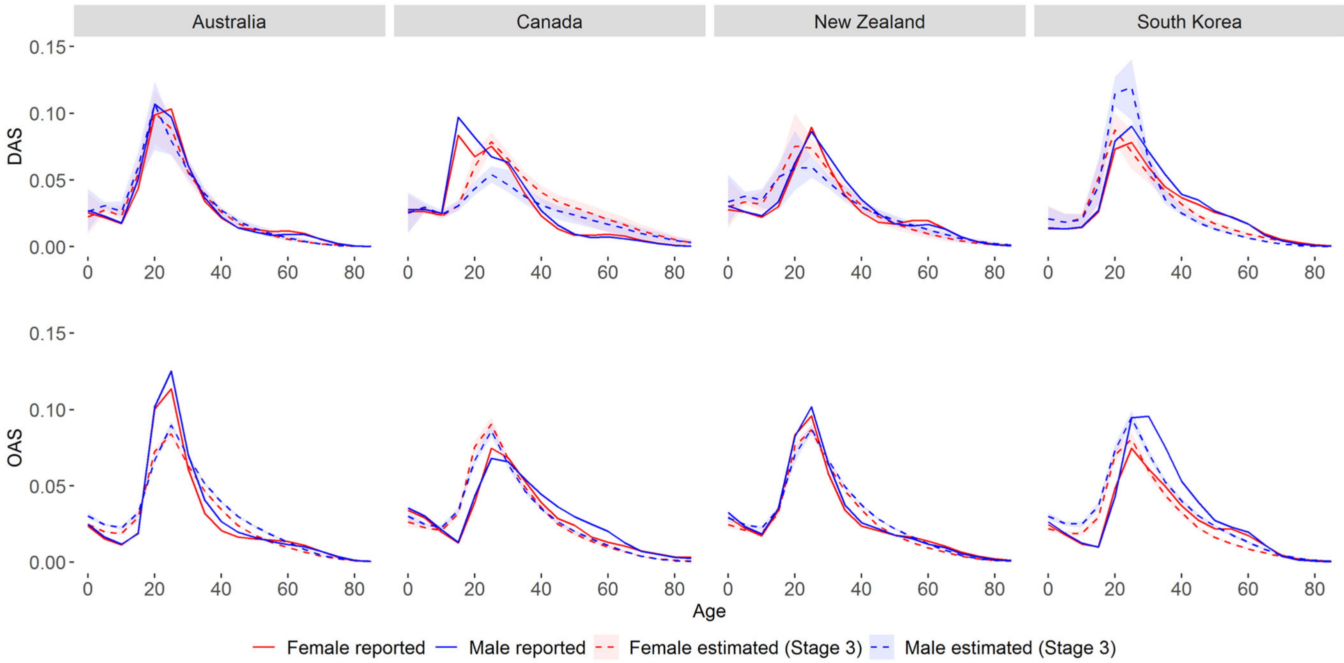

FIGURE 5 Comparison between estimated and reported immigrants and emigrants by the proportion of age and sex, 2019. The dashed line represents median estimates, and 80% prediction interval is shown in the shaded area. *Sources*: Author's calculations, Australian Bureau of Statistics (2021), Statistics Canada (2022), Statistics Korea (2022), Statistics New Zealand (2021).

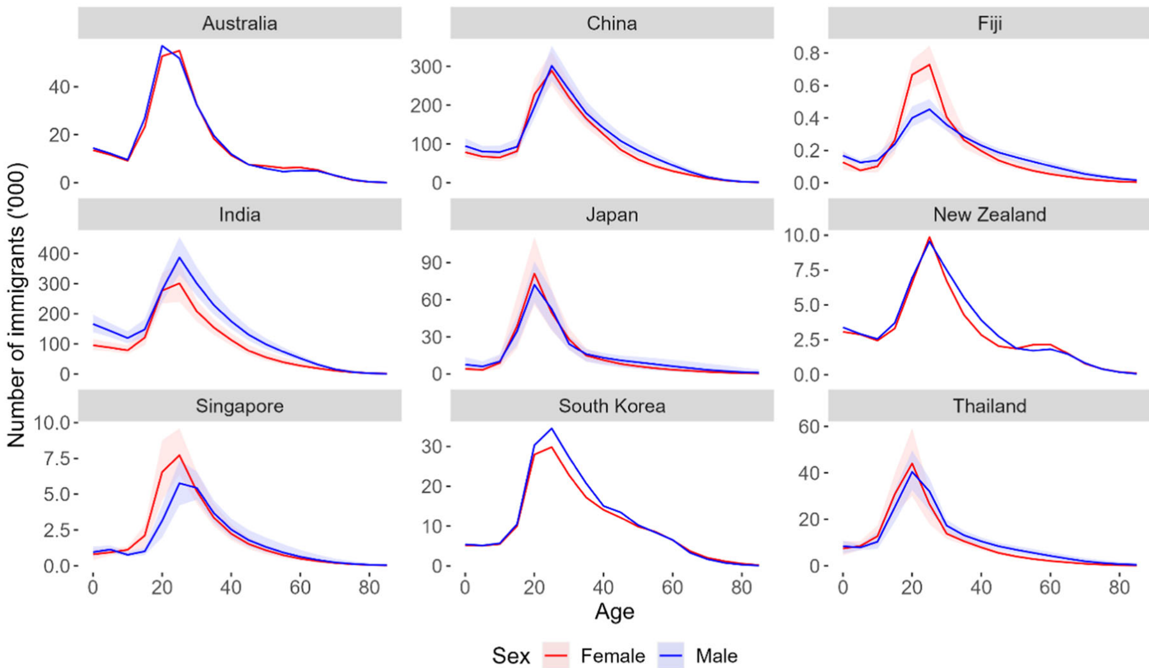

FIGURE 6 Estimated immigration by age and sex for nine selected countries, 2019. The line represents median estimates, and 80% prediction interval is shown in the shaded area. *Source*: Author's calculations.

always as high as the estimated levels, especially for emigration in Figure 8b.

We also compare our estimates with ILMS data, which primarily focus on labour migration from ASEAN countries. Most of the ILMS reported data are total number of migrants without sex breakdown. There are only six countries with available statistics and only Indonesia has information on both emigrants and immigrants. In Figure 9, error bars are Stage 4 estimates in 2019 with 80% prediction intervals and the triangle points are the averaged flows across all reported years in those six countries. The model appears to underestimate the female

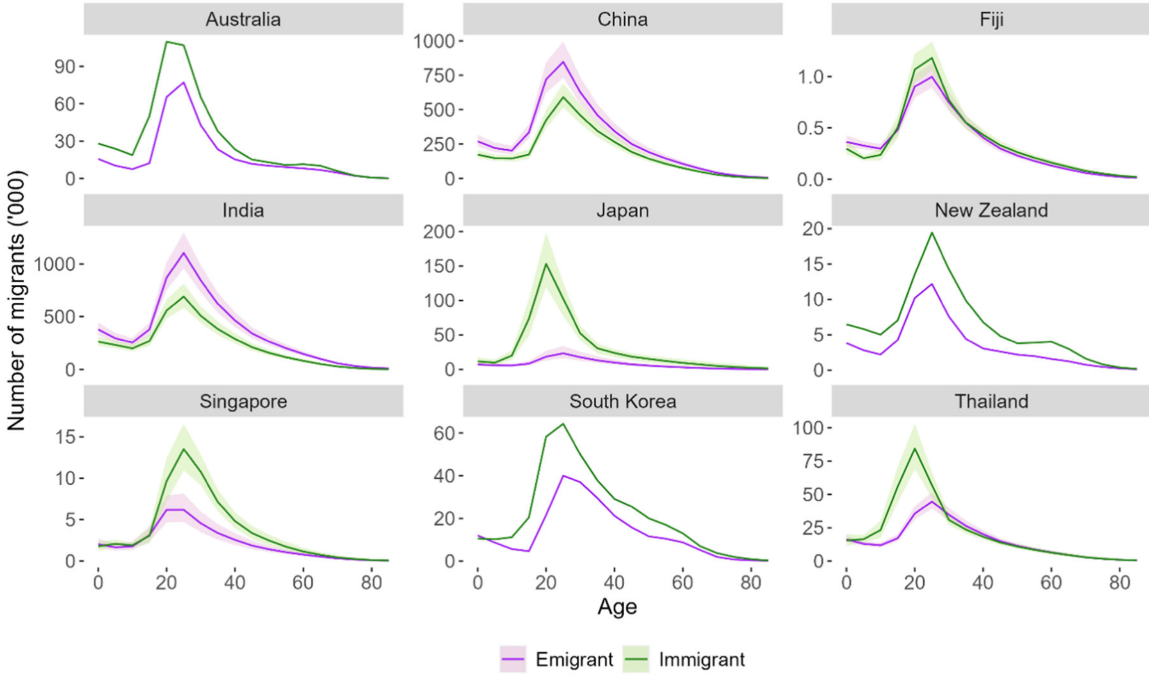

FIGURE 7 Estimated immigration and emigration by age for nine selected countries, 2019. The line represents median estimates. The 80% prediction intervals are shown by the shaded areas. *Source*: Author's calculations.

proportion of migrants in Indonesia and the Philippines, while overestimate in Myanmar, Cambodia and Thailand. The rather large mismatches could be due to inconsistent definitions in the ILMS.

The final set of measurements is derived from normalized migration intensities. Normalized migration intensities represent rescaled age-specific immigration and emigration rates that sum to one. We use annual numbers of persons in the population by 5-year age groups from United Nations WPP (2019b)[1] to compute age-specific immigration rates[2] and age-specific emigration rates. In this assessment, we adopt two indications: age at peak (AP) and peak migration intensity (PMI). These two indicators can capture the two key aspects of migration age profile: concentration and age selectivity (Bernard et al., 2014a). AP describes the age at the highest migration intensity, whereas PMI describes the level of migration at that peak age. Analysing these summary statistics of age profile, we find that AP for female is generally younger than for male. The average ages of female immigrants and emigrants are 26.9 and 26.7 years, respectively, while male immigrants and emigrants are 27.5 and 27.8 years, respectively. The PMI is the sum of normalized immigration intensity or normalized emigration intensity to the peak age group with its two adjacent age groups. There are a few small countries, such as Timor-Leste and Samoa, having rather high AP likely because of their nonstandard age schedules. For most countries, the AP is close to the average age and the PMI is about the same for both sexes. The values of these two statistics for all countries can be found in Appendix C.

[1]Data for some of the small Oceania countries/areas are unavailable.

[2]Note that the age-specific immigration rate is technically not a rate but a ratio, as the denominator is not the population at risk of immigration. It is used as a comparison index informing the relative size of immigration at different age groups.

6 | DISCUSSION

This paper presents a methodology for estimating the age- and sex-specific migration flows in Asia-Pacific countries in the context of very sparse data. The estimates are drawn from a multiplicative component framework that allows the systematic incorporation of information from different data sources. As hardly any published data exist on the migration flow patterns, let alone the corresponding age and sex patterns, the estimates rely on a series of assumptions, which were integrated in four steps into the model framework. The estimates include measures of uncertainty that combine the uncertainty of the previously estimated origin–destination flows of migration (Raymer et al., 2022) with the uncertainty of the estimated age and sex profiles of migration. The result is a detailed data set of annual migration flows for 53 countries and 4 world regions cross-classified by origin, destination, age and sex from 2000 to 2019.

There are two main contributions arising from this research. The first is the set of detailed international migration flows that include age and sex. We know very little about international migration in the Asia-Pacific region and this research sheds light on the possible patterns and the basic characteristics of the migrants. The estimates can be used to better understand gender differences in migration, migrant population change and the needs and vulnerabilities of growing migrant populations in and beyond the region.

The second is the provision of a methodological framework for estimating the age and sex profiles of migration flows in the context of very limited data. The framework is flexible. It can be updated or

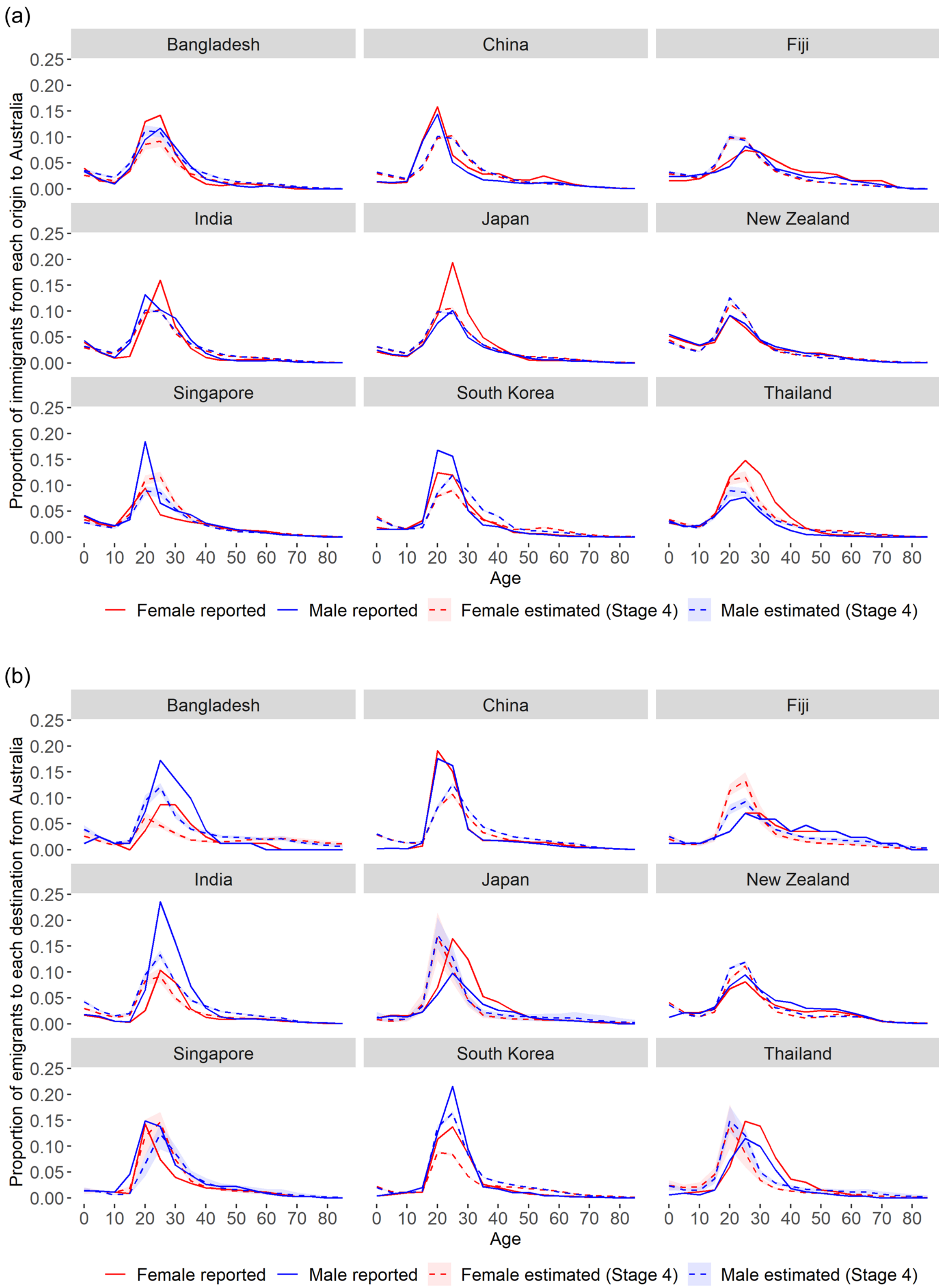

FIGURE 8 Comparing Stage 4 estimates in 2013 with reported age and sex proportion of migration from/to Australia of selected countries. (a) Immigration to Australia by country of origin. (b) Emigration from Australia by country of destination. *Note*: The dashed line represents median estimates. The 80% prediction intervals are shown by the shaded areas. *Sources*: Author's calculations, Australian Bureau of Statistics (2016).

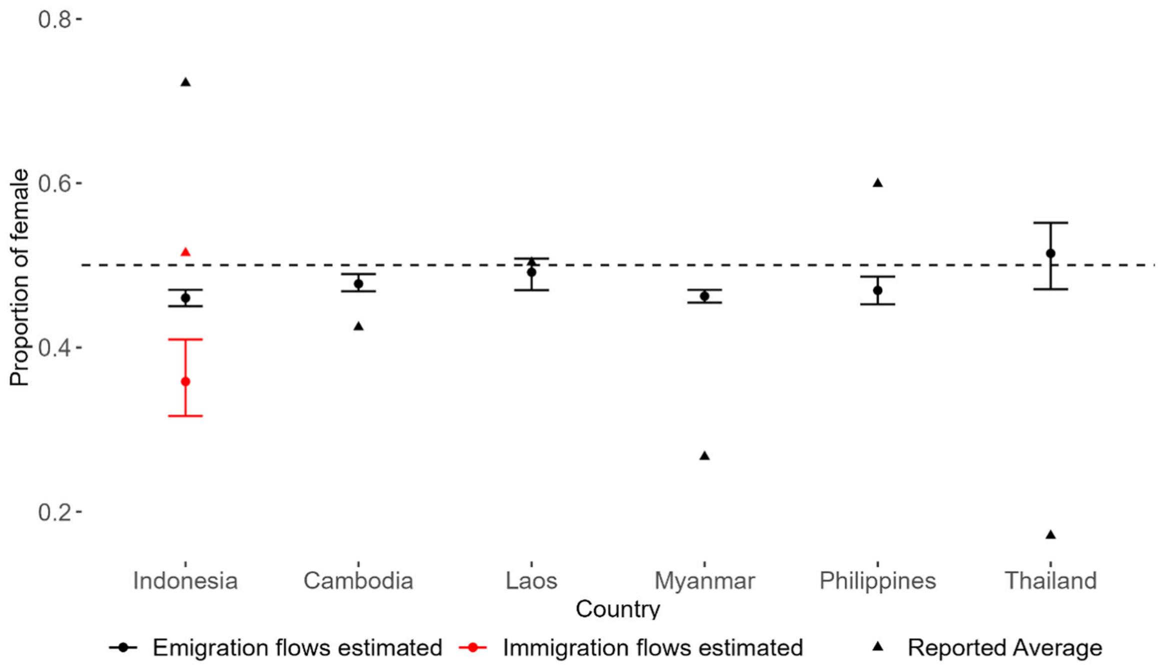

FIGURE 9 Comparison of estimated female migration proportions of immigration and emigration in 2019 with data reported in ILMS. The points represent median estimates. The 80% prediction intervals are the areas between error bars. *Sources*: Author's calculations, International Labour Organization (2018).

expanded as new information, including covariate information, becomes available. Surveys and new forms of data can also provide additional insights (cf. Alexander et al., 2022; Gendronneau et al., 2020; Wiśniowski, 2017). For instance, more interaction effects could be included in the model framework when new data emerge, such as more distinct age profiles by country of origin. The framework can also incorporate more advanced methodological procedures, such as time series models and smoothing of temporal patterns to model, for example, the change over time of age or sex profiles of migration. One could also use log-linear models within Bayesian inferential framework to produce more robust measures of uncertainty.

The model for age and sex patterns can be extended to include more countries or regions in the world where data are sparse. To do this, one would also have to model the origin-destination flows by adapting existing models (e.g., Abel & Cohen, 2022; Raymer et al., 2022) or developing new ones. This would greatly increase our understanding of international migration for developing countries in Africa, South and Central America, and Central and Western Asia, where flow data are nearly non-existent.

Further work is needed to validate the age- and sex-specific estimates of international migration. This is difficult considering the large absence of reliable data. While Australia, New Zealand and South Korea provide the best data in the region, their migration patterns are very different from other countries in the region, such as the Solomon Island, China, Indonesia or India. One obvious way to validate the estimates would be to include them in a cohort component population projection and compare the resulting projected populations with observed or reported figures or other projections contained in the United Nations Population Division's World Population Prospects,[3] Wittgenstein Centre's Human Capital Data Explorer[4] or the World Bank's DataBank on population estimates and projections.[5] Another possible path would be to consult the results with country-level experts about the likelihood of the estimates. Information from such consultation could then be fed back into the model for potentially improved estimates (Wiśniowski et al., 2013).

In conclusion, this paper provides a foundation for understanding the age and sex dynamics of international migration in the Asia-Pacific region and a basis for making demographic projections. This work also demonstrates that more attention and research initiatives are needed to initiate further exploratory studies to determine the origin, destination, age and sex patterns of migration in the Asia-Pacific region.

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[3]https://www.un.org/development/desa/pd/
[4]http://dataexplorer.wittgensteincentre.org/wcde-v2/
[5]https://databank.worldbank.org/source/population-estimates-and-projections

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available in UN International Migrant Stock 2020 at https://view.officeapps.live.com/op/view.aspx?src=https://www.un.org/development/desa/pd/sites/www.un.org.development.desa.pd/files/undesa_pd_2020_ims_stock_by_age_sex_and_destination.xlsx&wdOrigin=BROWSELINK and in OECD International Migration Database https://stats.oecd.org/Index.aspx?DataSetCode=MIG. Other sources of openly available data can be found in the reference list.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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APPENDIX A: LIST OF COUNTRIES (OR AREAS)

TABLE A1 Population sizes (in thousands) of Asia-Pacific countries, 2000 and 2019.

Region	Code/Country or area	2000	2019
E Asia	CHN China	1,290,551	1,433,784
	HKG China, Hong Kong SAR	6606	7436
	MAC China, Macao SAR	428	640
	TWN China, Taiwan Province of China	21,967	23,774
	PRK Dem. People's Republic of Korea	22,929	25,666
	JPN Japan	127,524	126,860
	MNG Mongolia	2397	3225
	KOR Republic of Korea	47,379	51,225
S-E Asia	BRN Brunei Darussalam	333	433
	KHM Cambodia	12,155	16,487
	IDN Indonesia	211,514	270,626
	LAO Lao People's Democratic Republic	5324	7169
	MYS Malaysia	23,194	31,950
	MMR Myanmar	46,720	54,045
	PHL Philippines	77,992	108,117
	SGP Singapore	4029	5804
	THA Thailand	62,953	69,626
	TLS Timor-Leste	884	1293
	VNM Vietnam	79,910	96,462
S Asia	AFG Afghanistan	20,780	38,042
	BGD Bangladesh	127,658	163,046
	BTN Bhutan	591	763
	IND India	1,056,576	1,366,418
	IRN Iran (Islamic Republic of)	65,623	82,914
	MDV Maldives	279	531
	NPL Nepal	23,941	28,609
	PAK Pakistan	142,344	216,565
	LKA Sri Lanka	18,778	21,324

TABLE A1 (Continued)

Region	Code/Country or area	2000	2019
Oceania	ASM American Samoa	58	55
	AUS Australia	18,991	25,203
	COK Cook Islands	18	18
	FJI Fiji	811	890
	PYF French Polynesia	241	279
	GUM Guam	155	167
	KIR Kiribati	84	118
	MHL Marshall Islands	51	59
	FSM Micronesia (Fed. States of)	107	114
	NRU Nauru	10	11
	NCL New Caledonia	217	283
	NZL New Zealand	3,859	4,783
	NIU Niue	2	2
	MNP Northern Mariana Islands	57	57
	PLW Palau	19	18
	PNG Papua New Guinea	5848	8776
	WSM Samoa	174	197
	SLB Solomon Islands	413	670
	TKL Tokelau	2	1
	TON Tonga	98	104
	TUV Tuvalu	9	12
	VUT Vanuatu	185	300
	WLF Wallis and Futuna Islands	15	11
N America	CAN Canada	30,588	37,411
	USA United States	281,711	329,065
Other	ROA Rest of Asia	239,905	348,537
	AFR Africa	820,062	1,308,164
	EUR Europe	723,476	747,183
	SCA Southern and Central America	521,781	648,121
Total		6,150,308	7,713,342

Source: United Nations (2019b). *Note*: Bermuda, Greenland and Saint Pierre and Miquelon are excluded.

APPENDIX B: SUMMARY OF METHODOLOGICAL FRAMEWORK

TABLE B1 A nontechnical summary of methodology.

Stage		Aim		Data	Main procedure	Existing effects	New/revised effects
1		Integrate overall age and sex profile		I. Estimates of migration flows by origin & destination (2000–2019) II. Australian immigrants & emigrants by age & sex (2000–2019) III. Canadian immigrants & emigrants by age & sex (2000–2019) IV. South Korean immigrants & emigrants by age & sex (2000–2019) V. New Zealand's immigrants & emigrants by age & sex (2001–2019)	1. Generate general age profiles by sex from reported values (Data II, III, IV and IV) with LOESS regression. 2. Set the overall sex effect S_y to 0.5. 3. Integrate the age and sex profile with Data I.	(O_i), (D_j), (OD_{ij})	(A_x), (S_y), (AS_{xy})
2	2a	Integrate age and sex profile by destination	Estimate foreign immigrants age and sex profile by destination	I. United Nations International Migrant Stock 2020 by age and sex for 52 destinations (1990, 1995, 2000, 2005, 2010, 2015, 2020) II. United Nations World Population Prospect 2019 Life Table by sex for 52 populations (1990, 1995, 2000, 2005, 2010, 2015, 2020)	1. Compute the change in stock by reverse cohort-component projection accounting for survivals. 2. Rescale the age and sex pattern to positive and extend older age groups (75-79, 80–84, and 85+) with model migration schedule.	(O_i), (D_j), (A_x), (S_y), (AS_{xy}), (OD_{ij})	(S_y), (AS_{xy}), (DS_{jy}), (DA_{jx}), (DAS_{jxy})
	2b		Estimate returning nationals age and sex profile by destination	I. Australian-born arrival by age and sex (2000–2013) II. South Korean national arrival by age and sex (2000–2019) III. Return Japan national by age and sex (2006–2019) IV. OECD outflow of foreigners by sex and destination from Australia (2000–2016), South Korea (2000–2018) and New Zealand (2000–2018)	1. Generate general age profiles by sex for returning nationals from reported values (Data I, II and III) with LOESS regression. 2. Adjust sex profile by destination with Data IV.		
	2c		Estimate the proportion of returning nationals	I. Estimates from Stage 1 (2000–2019) II. Net migration rate from estimates of migration flows by origin & destination (2000–2019) III. Migration efficiency from estimates of migration flows by origin & destination (2000–2019) IV. Percentage migrant population calculated from International Migrant Stock 2019 (United	1. Estimate fractional logistic regression between reported proportions (Data V, VI and VII) and indices related to migration impact (Data II, III and IV). 2. Apply the regression coefficients to all destinations with Data II, III and IV and obtain the average proportion of returning nationals for each destination.		

(Continues)

TABLE B1 (Continued)

Stage		Aim		Data	Main procedure	Existing effects	New/revised effects
				Nations, 2019a) & World Population Prospect 2019 (United Nations, 2019b) V. Australian immigrants by place of birth (2000–2013) VI. South Korean immigrants by citizenship (2000–2019) VII. New Zealand's immigrants by prior residency (2001–2019)	3. Join the two profiles above by this proportion for each destination. 4. Integrate the age and sex and destination profiles with data I.		
3	3a	Adjust sex profile by origin and by destination	Adjust sex effect for four rest of the world (ROWs) destinations	I. Estimates from Stage 2 (2000–2019) II. Abel & Cohen's (2022) estimates of migration transition by destination and sex (2000, 2005, 2010, 2015)	1. Calculate the average sex profile for the four ROWs as destinations in Abel and Cohen's (2022) (Data II) across time. 2. Combine sex profiles by destination of Stage 2 (Data I) and Abel and Cohen's (2022) estimates by weight. 3. Obtain new age and sex and destination profiles including the new overall sex profile.	(O_i), (D_j), (A_x), (S_y), (AS_{xy}), (OD_{ij}), (DS_{jy}), (DA_{jx}), (DAS_{jxy})	(S_y), (AS_{xy}), (DS_{jy}), (DAS_{jxy})
	3b		Adjust sex effect for origins	I. Estimates from Stage 2 (2000–2019) II. Abel and Cohen's (2022) estimates of migration transition by origin and sex (2000, 2005, 2010, 2015)	1. Calculate the average sex profile for each origin in Abel and Cohen's (2022) estimates (Data II) across time. 2. Combine sex profiles by origin of Stage 2 (Data I) and Abel and Cohen's (2022) estimates by weight controlling for the new overall sex profile in Stage 3a. 3. Integrate these new profiles with Data I.	(O_i), (D_j), (A_x), (S_y), (AS_{xy}), (OD_{ij}), (DS_{jy}), (DA_{jx}), (DAS_{jxy})	(OS_{iy})
4		Replace profiles by reported data		I. Estimates from Stage 3 (2000–2019) II. Australian immigrants & emigrants by age and sex (2000–2019) III. South Korean immigrants and emigrants by age and sex (2000–2019) IV. New Zealand's immigrants & emigrants by age and sex (2001–2019) V. Canadian immigrants & emigrants by age and sex (2000–2019)	Replace the estimates with reported age and sex profile by total immigration and emigration controlling for OD and AS	(O_i), (D_j), (A_x), (S_y), (AS_{xy}), (OD_{ij}), (DS_{jy}), (DA_{jx}), (OS_{iy}), (DAS_{jxy})	(DS_{jy}), (DA_{jx}), (OS_{iy}), (OA_{ix}), (DAS_{jxy}), (OAS_{ixy})

Note: Sources of data can be found in the references.

APPENDIX C: SUMMARY INDICATORS OF THE ESTIMATES

This appendix provides the table of two summary indicators of our estimates: age at Peak (AP) and peak migration intensity (PMI) by country, sex and migration direction. To get these two indicators, age-specific immigration rates and age-specific emigration rates are used. These rates are calculated by dividing the number of immigrants or emigrants in each age group by the corresponding mid-year population.[6] To calculate rates, we use annual numbers of persons in the population by 5-year age groups from United Nations WPP (2019b). Data for some of the small Oceania countries are missing. Moreover, for the older age groups with many zeros, we randomly impute population numbers from 100 to 499 to avoid undefined rates. Since our estimates are in 5-year age groups, AP is calculated as the age group at peak. After identifying the age group at peak, we use the weighted average of migration intensity from the age groups before and after to determine the AP. For example, if the age group at peak is 25–29 and the migration intensity of the age groups before and after are 4% and 6%, respectively, the AP would be $25 + 5*(\frac{4\%}{4\% + 6\%}) = 27$. PMI is calculated as the migration intensity of the age group at peak with its two adjacent age groups.

See Table C1.

TABLE C1 Age at peak (AP) and peak migration intensity (PMI) by sex, country and migration direction.

Country code	Emigration Female AP	Emigration Male AP	Emigration Female PMI (%)	Emigration Male PMI (%)	Immigration Female AP	Immigration Male AP	Immigration Female PMI (%)	Immigration Male PMI (%)
AFG	28	29	23.0	21.7	32	29	21.1	14.3
AUS	26	26	54.3	53.4	24	24	49.3	49.4
BGD	27	28	33.3	32.2	24	27	12.6	20.7
BRN	24	24	35.8	32.8	24	24	38.6	54.7
BTN	27	28	32.9	27.4	26	23	15.7	46.5
CAN	29	32	33.9	31.7	19	20	39.2	41.5
CHN	24	26	40.3	38.8	26	27	43.1	36.9
FJI	27	27	35.0	30.2	26	27	43.8	22.3
FSM	27	27	34.0	29.7	37	29	22.6	34.1
GUM	28	28	39.0	34.7	27	23	43.8	36.2
HKG	24	27	42.5	39.4	23	28	50.5	28.9
IDN	27	27	40.4	36.8	28	29	20.4	29.2
IND	27	28	34.8	31.9	27	28	38.5	32.1
IRN	24	27	33.8	31.7	25	27	12.9	19.3
JPN	27	27	48.7	45.4	23	23	67.6	61.6
KHM	24	27	31.7	26.5	32	32	17.4	22.9
KIR	24	28	34.0	24.4	28	37	21.1	17.5
KOR	28	32	40.8	44.0	27	27	43.7	43.8
LAO	24	27	31.2	26.0	28	28	24.4	24.8
LKA	27	28	45.3	42.4	28	29	42.5	33.9
MAC	23	27	40.5	32.3	21	23	57.5	51.9
MDV	23	18	25.5	15.7	25	22	28.9	26.2

(Continues)

[6] Note that age-specific immigration rate is technically not a rate but a ratio, as the denominator is not the population at risk of immigration. It is used as a comparison index informing the relative size of immigration at different age groups.

TABLE C1 (Continued)

Country code	Emigration Female AP	Emigration Male AP	Emigration Female PMI (%)	Emigration Male PMI (%)	Immigration Female AP	Immigration Male AP	Immigration Female PMI (%)	Immigration Male PMI (%)
MMR	24	27	33.6	30.5	28	29	25.9	30.9
MNG	27	27	36.3	29.8	23	26	32.2	31.1
MYS	27	28	29.4	29.3	22	22	46.3	56.6
NCL	28	28	43.0	35.7	28	28	28.9	24.7
NPL	28	33	33.8	38.9	22	32	35.2	35.5
NZL	27	27	45.2	44.0	28	28	40.5	37.5
PAK	28	28	31.0	28.2	27	28	41.4	33.1
PHL	28	28	36.4	31.1	28	29	32.9	20.6
PNG	28	28	25.6	25.1	29	29	31.7	26.8
PRK	28	28	42.8	35.2	27	28	45.4	31.9
PYF	27	27	40.5	39.1	28	28	42.6	35.8
SGP	23	23	40.2	37.5	27	29	53.4	42.6
SLB	28	29	35.0	27.8	28	29	31.7	30.8
THA	27	28	40.1	39.3	22	23	55.1	43.2
TLS	38	38	25.1	31.1	38	38	16.4	34.0
TON	28	28	37.9	33.4	32	32	23.9	15.9
TWN	27	28	40.7	37.8	27	28	44.8	41.7
USA	27	28	43.0	38.9	27	24	45.0	45.5
VNM	24	27	35.8	34.7	27	27	39.5	34.6
VUT	27	28	26.3	27.0	27	28	42.1	32.7
WSM	32	32	31.0	27.6	33	38	18.9	13.4

Note: Population data are missing in ASM, COK, MHL, NRU, NIU, MNP, PLW, TKL, TUV and WLF, so these countries/areas are excluded.
Sources: Authors' calculations; United Nations (2019b).