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The Impact of Migration on Population Ageing in Asia 1990-2020: A Decomposition Analysis Using Prospective Age

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Abstract: Population ageing has become a global trend, which unfolds at different speeds across world regions and countries. In Asia, there are countries with rapidly ageing populations and those that continue to maintain a younger age structure. One potential driver of this difference is international migration. In this study, I assess the impact of migration on population ageing in Asian countries over the period 1990-2020. To do so, I propose a refined decomposition method, applying a prospective view on population ageing that accounts for variation in life expectancy. Using data from the United Nations World Population Prospects 2022, changes in the prospective old-age dependency ratio in 51 countries are decomposed into the effects of cohort turnover, deaths, changes in life expectancy and net migration. The results reveal that cohort turnover and deaths have had the largest impact on changes in the prospective old-age dependency ratio over the last three decades, whereas the impact of international migration and changes in life expectancy was smaller in all countries. However, in countries with either highly negative or highly positive net migration, the effect of migration on the age structure is substantial. As migration largely occurs at younger ages, high immigration has decelerated or even halted the process of population ageing in countries such as Bahrain, Macao, Oman and Singapore. The opposite effect is observed in emigration countries such as Armenia, Georgia and Timor-Leste. Hence, the large differences in the current level of population ageing across Asian countries can at least partly be attributed to international migration in the last decades.

Keywords: Population ageing · Asia · Prospective age · Migration · Decomposition analysis

1 Introduction

Population ageing, characterized by increasing shares of older individuals in a population, is an inevitable part of the demographic transition (*Goldstein* 2009) and linked to various opportunities and challenges for economies and societies worldwide (United Nations Department of Economic and Social Affairs (*UN DESA*)

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2023). However, the timing, speed and extent of population ageing vary across countries. This is attributable to different fertility and mortality trajectories as well as to migration. A large body of research exists on the impact of these factors on the age structure using stationary or stable population models (e.g. *Alho* 2008; *Coale* 1957; *Espenshade et al.* 1982), counterfactual population projections (e.g. *Blanchet* 1989; *Coale* 1986; *Coleman* 2008; *Espenshade* 1994; *Fihel et al.* 2023; *Lee/Zhou* 2017; *Lesthaeghe et al.* 1988; *Lutz/Scherbov* 2007; *McDonald/Kippen* 2001; *Murphy* 2021), decomposition approaches (e.g. *Caselli/Vallin* 1990; *de Beer et al.* 2011; *Fernandes et al.* 2023; *Horiuchi* 1991; *Kashnitsky et al.* 2017; *Murphy* 2017; *Preston et al.* 1989; *Preston/Vierboom* 2021), cointegration analysis (*Santis/Salinari* 2023) or the variable-r method (*Canudas-Romo et al.* 2021).

Although the results of these studies may vary in detail depending on methodologies, two main conclusions can be drawn. First, while fertility decline is the main driver of population ageing, mortality improvements play a substantial role at later phases of the demographic transition. Second, migration can have a rejuvenating or an ageing effect on a population, depending on the age structure of the migrants and of the resident population. In addition to the direct impact at the time of migration, migrants' fertility indirectly affects the age structure in the long term (*Sobotka* 2008). As shown for Europe, different patterns of population ageing across countries and regions can be attributed partly to migration (*de Beer et al.* 2011; *Ghio et al.* 2022; *Kashnitsky et al.* 2017). Similar conclusions about the role of migration in ageing countries are drawn from studies on replacement migration, indicating that realistic levels of immigration cannot offset population ageing completely but can to some extent slow down the process (e.g. *Bijak et al.* 2008; *Billari/Dalla-Zuanna* 2011; *Craveiro et al.* 2019; *Huguet* 2003; *UN DESA* 2000).

While many empirical studies on the drivers of population ageing focus on European and North American countries, Asia presents a particularly intriguing world region for a comparative analysis of the impact of migration on age-structure changes. First, the level and speed of population ageing vary substantially across Asian countries (*Balachandran et al.* 2020; *Gietel-Basten et al.* 2016). Aside from the prominent example of Japan, which has one of the oldest populations in the world, population ageing is rapidly advancing in several other countries (e.g. South Korea), while other countries continue to maintain a relatively young age structure. Life expectancy has also developed very differently, with some countries (e.g. Hong Kong) having some of the highest life expectancies worldwide (*UN DESA* 2022b).[1] Second, Asian countries demonstrate quite diverse migration patterns, ranging from high immigration (e.g. United Arab Emirates) to high emigration (e.g. Georgia) (ibid.). Moreover, migration patterns and policies in Asia have been subject to profound changes over time (*Ali/Cochrane* 2024; *de Haas et al.* 2018; *Oishi* 2021). In this context, understanding the impact of migration on population ageing is crucial to comprehending Asia's heterogeneous demographic landscape.

1 When referring to the statistical units provided by the UN simply as "countries", no opinion on the legal status of these countries, territories or areas, its authorities, or the delimitation of its frontiers or boundaries is expressed.

Within the large body of research on the drivers of age-structure changes, age is predominantly measured as chronological age, i.e. the number of years a person has lived.[2] Chronological indicators of population ageing, such as the old-age dependency or the total support ratio, are based on a fixed threshold to define who is considered old, mostly at age 60 or 65. However, as noted by *Scherbov* and *Sanderson* (2020), chronological age is only one dimension of ageing and many characteristics of individuals are ignored when using these conventional measures.

Several new approaches have been elaborated recently to account for additional characteristics beyond chronological age, using risk of death (*Alvarez/Vaupel* 2023; *Zuo et al*. 2018), health care needs (*Spijker* 2023), distribution of ages within a population (*d'Albis/Collard* 2013), physical health (*Demuru/Egidi* 2016; *Muszyńska/Rau* 2012; *Sanderson/Scherbov* 2010), cognitive functioning (*Skirbekk et al*. 2012) and active life expectancy (*Manton et al*. 2006). Prospective age, likely the most common alternative measure of population ageing, links a person's age to the average remaining life expectancy (*Sanderson/Scherbov* 2005). The central idea of this approach is that a person's characteristics, such as physical and cognitive health, depend more on the expected remaining years of life (prospective age) than on the number of years lived (chronological age). Hence, prospective measures may better capture many of the economic and social implications of population ageing. For instance, medical expenditures are concentrated in the final years of life (*Sanderson/Scherbov* 2007). Prospective age becomes particularly relevant as (healthy) life expectancy tends to increase over time in most countries (*Global Burden of Disease Collaborative Network* 2020; *Rau et al*. 2008; *Vaupel et al*. 2021). Thus, a 65-year-old today is on average healthier and lives longer than in 1950. In fact, global remaining life expectancy at age 65 has increased from 11.3 years in 1950 to 17.5 years in 2019 (*Scherbov et al*. 2022). Considering these life expectancy increases and health improvements, prospective measures indicate a slower speed of population ageing than chronological measures (*Sanderson/Scherbov* 2008; *UN DESA* 2019).

Life expectancy varies not only over time but also across countries and regions. For instance, the characteristics of an average person at a given chronological age in a low-mortality country (e.g. Japan) are barely comparable to those of an average person at the same chronological age in Afghanistan, where mortality is much higher and (remaining) life expectancy much lower. These differences become explicitly relevant when defining who is considered "dependent" in a population. The widely used fixed old-age threshold of 65 years, which marks an historically and contemporarily common retirement age in many countries, is based on the assumption that the retired population is entirely dependent on the tax contributions of those who work (*Gietel-Basten et al*. 2015). In many Asian countries, however, the coverage of the public pension systems is low (Organisation for Economic Co-operation and Development (*OECD*) 2022), and informal employment rates are high (International Labour Organization (*ILO*) 2024). In this context, prospective measures

2 An exception is the study on replacement migration by *Craveiro et al*. (2019), which uses prospective age.

appear to be more suitable for a comprehensive understanding of population ageing in Asia. However, this new perspective is rarely incorporated into the analysis of the drivers of population ageing.

In this paper, I present an approach to incorporate the prospective age concept into a decomposition of age-structure changes. The study aims to assess the drivers of population ageing in Asian countries over the period 1990-2020, with a particular focus on the role of migration.[3]

2 Data and methods

2.1 Data

This study uses a) annual population and deaths counts by single age and b) life expectancy by single age (both sexes) for the definition of prospective age. These data are drawn from the United Nations' World Population Prospects (WPP) 2022 estimates (*UN DESA* 2022b). The UN WPP 2022 estimates are based on population and household censuses, vital and population registration systems, surveys and other sources (e.g. UNHCR data on refugees) (*UN DESA* 2022a). Following the UN definition of geographic regions, 51 Asian countries are included in the analysis: 5 from Central Asia, 8 from Eastern Asia, 11 from South-Eastern Asia, 9 from Southern Asia and 18 from Western Asia.

2.2 Indicators of population ageing

The old-age dependency ratio of the (dependent) old-age population relative to the working-age population is a common measure of the potential burden of population ageing. This ratio is used as the key indicator in this study.[4] Conventionally, individuals are considered to enter old-age at 65, while the working-age population includes the population of age 15 to 64. Therefore, the (chronological) old-age dependency ratio is defined as follows:

$$\text{(Chronological) old-age dependency ratio (OADR)} = \frac{\text{old-age population}}{\text{working-age population}} = \frac{\sum_{\text{age}=65}^{\text{age}=100+} \text{Pop.}}{\sum_{\text{age}=15}^{\text{age}<65} \text{Pop.}}$$

In contrast to the chronological approach, which uses a constant old-age threshold at age 65, the prospective old-age threshold (POAT) is determined by the average

[3] In this study, when referring to migration, international migration is implied unless otherwise specified.

[4] Other studies on population ageing use the total support ratio or potential support ratio, which is the reciprocal of the old-age dependency ratio. However, the use of the term "support ratio" is sometimes ambiguous (*Kashnitsky et al.* 2017), so I use the old-age dependency ratio in this study.

remaining life expectancy. The most common definition of the prospective old-age threshold is the age when the remaining life expectancy equals 15 years (*Sanderson/ Scherbov* 2013). Since life expectancy varies over time and across populations, this threshold is dynamic. However, *Sanderson* and *Scherbov* (2020) have shown that death rates, as an indicator of health, are approximately constant at this threshold across populations over time and space. The prospective old-age thresholds by country for the years 1990 and 2020 are reported in Appendix Table A1. The old-age population is defined for each country and year as the population at age=POAT and older, while the working-age population includes the population aged 15 and over but younger than the prospective old-age threshold. The prospective old-age dependency ratio (POADR) is then the ratio between the two age groups according to the prospective definition:

$$\text{Prospective old-age dependency ratio (POADR)} = \frac{\text{prosp. old-age population}}{\text{prosp. working-age population}} = \frac{\sum_{\text{age=POAT}}^{\text{age=100+}} \text{Pop.}}{\sum_{\text{age=15}}^{\text{age<POAT}} \text{Pop.}}$$

2.3 Decomposition analysis of changes in the prospective old-age dependency ratio

To assess the drivers of age-structure changes in Asian countries, I conduct a decomposition analysis of changes in the prospective old-age dependency ratio over the period 1990-2020. The end of the period is set at the beginning of year 2020 to avoid any effects of excess mortality during the Covid-19 pandemic starting in 2020 (World Health Organization (*WHO*) 2023). Life expectancy for 2020 is obtained from the 2019 life table. Similar to decomposition analyses based on chronological age (*de Beer et al*. 2011; *Ghio et al*. 2022; *Kashnitsky et al*. 2017), cohort turnover, deaths and migration effects are taken into account. First, the cohort turnover effect depends on the number of individuals entering working-age and the number of individuals leaving working-age and entering old-age. Thus, the cohort turnover effect is an indicator of the age structure, which in turn is the long-term result of fertility, mortality and migration. Second, the deaths effect is defined by the number of deaths in working-age and old-age, respectively. Third, the migration effect is based on the number of net migrants of working-age and in old-age, respectively.

When using prospective age, the definition of the relevant age groups shifts with changing life expectancy. Hence, I extend the decomposition method by adding an effect which accounts for the additional cohort turnover due to changes in the prospective old-age threshold. In case of life expectancy improvements, the prospective old-age threshold – the age at which the average remaining life expectancy equals 15 years – increases. In such instances, the effect of changes in life expectancy (LE) is determined by the additional number of individuals that "remain" in the working-age population and do not enter old-age due to the increase in the prospective old-age threshold. When life expectancy decreases, as observed at least temporarily in some countries, the effect is defined by the additional number of individuals that leave working-age and enter old-age due to the reduction in the prospective old-age threshold. It should be noted that changes in life expectancy imply changes in mortality rates, which, of course, in turn impact the effect of deaths. In this paper, however, the effect of changes in life expectancy refers only to the effect of changes in the average remaining life expectancy and thus changes in the prospective old-age threshold.

Equation 1 describes the changes in the prospective old-age population (POA; numerator of the POADR) from the beginning of year t to the beginning of year t+1 considering the prospective old-age thresholds in the two consecutive years (POAT(t) and POAT(t+1)). The changes in the POA are attributed to the four components described above:

1) $$\Delta \mathrm{POA}(t, t{+}1) = \mathrm{POA}(t{+}1) - \mathrm{POA}(t) =$$

$$\sum_{\mathrm{age}=\mathrm{POAT}(t+1)}^{\mathrm{age}=100+} \mathrm{Pop.}(t{+}1) - \sum_{\mathrm{age}=\mathrm{POAT}(t)}^{\mathrm{age}=100+} \mathrm{Pop.}(t) =$$

$$CT_{POA}(t) - D_{POA}(t) + M_{POA}(t) + CT_{LEchange}(t)$$

where $CT_{POA}(t)$ is the cohort turnover in old-age, $D_{POA}(t)$ is the number of deaths in old-age, $M_{POA}(t)$ is the net migration in old-age and $CT_{LEchange}(t)$ is the additional cohort turnover into old-age due to changes in life expectancy.

Similarly, equation 2) describes the changes in the prospective working-age population (PWA; denominator of the POADR) from the beginning of year t to the beginning of year t+1:

2) $$\Delta \mathrm{PWA}(t, t{+}1) = \mathrm{PWA}(t{+}1) - \mathrm{PWA}(t) =$$

$$\sum_{\mathrm{age}=15}^{\mathrm{age}<\mathrm{POAT}(t+1)} \mathrm{Pop.}(t{+}1) - \sum_{\mathrm{age}=15}^{\mathrm{age}<\mathrm{POAT}(t)} \mathrm{Pop.}(t) =$$

$$CT_{PWA}(t) - D_{PWA}(t) + M_{PWA}(t) - CT_{LEchange}(t)$$

where $CT_{PWA}(t)$ is the cohort turnover in working-age minus the cohort turnover in old-age, $D_{PWA}(t)$ is the number of deaths in working-age, $M_{PWA}(t)$ is the net migration in working-age and $CT_{LEchange}(t)$ is the additional cohort turnover in old-age due to changes in life expectancy.

I assume that all migration takes place at the end of the year, which is a reasonable assumption if data are available by single year (*UN DESA* 2022a). Accordingly, migrants do not contribute to either cohort turnover or deaths occurring in the year of migration. Cohort turnover due to changes in life expectancy at the end of year $CT_{LEchange}(t)$ is positive if the prospective old-age threshold increases and negative if it decreases. If it remains stable, the effect size equals 0. The following example illustrates how changes in the prospective old-age threshold impact the equations above. We assume an increase of the prospective old-age threshold from 67 years (2000) to 68 years (2001). Hence, $CT_{LEchange}(2000)$ comprises all individuals aged 67 at the end of year 2000 – let us assume 100 individuals – since they would have entered old-age at the beginning of year 2001 if the prospective old-age threshold remained stable at age 67 but did not because it increased to age 68. These 100 individuals "remain" in the working-age population also in year 2001. Therefore, with $CT_{LEchange}(2000)$ equal to -100, the working-age population in year 2001 is 100 individuals larger and the old-age population is 100 individuals smaller than it would have been without any change in life expectancy.

Reliable data on international migration are lacking in many countries (*Willekens et al.* 2016). This is particularly the case when data on migration by age are needed, as is the case in this analysis. Therefore, I use the residual method to estimate net migration (*Siegel/Hamilton* 1952). Annual net migration by age group at the end of the year t is derived from equations (1) and (2) above:[5]

$$3)\ M_{POA}(t) = POA(t+1) - POA(t) - CT_{POA}(t) + D_{POA}(t) - CT_{LEchange}(t)$$

$$4)\ M_{PWA}(t) = PWA(t+1) - PWA(t) - CT_{PWA}(t) + D_{PWA}(t) + CT_{LEchange}(t)$$

Using these definitions of the annual changes in the size of the old-age and working-age populations, changes in the prospective old-age dependency ratio are decomposed using a two-step decomposition of a rate (*Kashnitsky et al.* 2017). First, changes in the prospective old-age dependency ratio are decomposed into changes in the size of the numerator (old-age population) and the denominator (working-age population). Second, each of these changes is further decomposed into the effects of the four demographic components introduced above (cohort turnover, deaths, migration, changes in life expectancy). In contrast to *Kashnitsky et al.* (2017), who focused only on changes in the working-age population, I decompose both the numerator and denominator effects, considering the effects of the demographic components on changes in the working-age population and changes in the old-age population.

In the first step, I make use of the formula for the decomposition of rates as a function of two factors (*Das Gupta* 1991):

$$5)\ POADR(t+1) - POADR(t) = \alpha\text{-effect} + \beta\text{-effect} = \left[\frac{1}{2} * \big(POA(t+1) - POA(t)\big) * \left(\frac{1}{PWA(t+1)} + \frac{1}{PWA(t)}\right)\right] + \left[\frac{1}{2} * \big(POA(t+1) + POA(t)\big) * \left(\frac{1}{PWA(t+1)} - \frac{1}{PWA(t)}\right)\right]$$

The first of the two terms on the right-hand side of equation 5) represents the α-effect, and the second represents the β-effect. The α-effect describes how changes in the size of the prospective old-age population (numerator of the ratio) affect the POADR. The β-effect describes how changes in the size of the prospective working-

5 The annual sum of the derived net migration by age group corresponds to the total annual net migration provided by the UN.

age population (denominator of the ratio) affect the POADR (*Das Gupta* 1993). The average α-effect across all 51 countries was -5.3 percentage points with a standard deviation of 3.0 percentage points. The average β-effect was +5.4 percentage points with a standard deviation of 2.3 percentage points.

In the second step of the decomposition, I further decompose the two effects from equation 5) into the effects of cohort turnover, deaths, migration and changes in life expectancy. First, I replace POA(t+1) − POA(t) in the formula for the α-effect with equation 1) (see Appendix Equation 1 for the step-by-step substitution):

$$6)\ \alpha\text{-effect} = \left[\frac{1}{2} * \left(\frac{1}{PWA(t+1)} + \frac{1}{PWA(t)}\right) * CT_{POA}(t)\right] + \left[-\frac{1}{2} * \left(\frac{1}{PWA(t+1)} + \frac{1}{PWA(t)}\right) * D_{POA}(t)\right] + \left[\frac{1}{2} * \left(\frac{1}{PWA(t+1)} + \frac{1}{PWA(t)}\right) * M_{POA}(t)\right] + \left[\frac{1}{2} * \left(\frac{1}{PWA(t+1)} + \frac{1}{PWA(t)}\right) * CT_{LEchange}(t)\right]$$

The four right-hand terms of equation 6) denote the effects of cohort turnover in old-age, deaths in old-age, net migration in old-age and changes in life expectancy on the numerator of the prospective old-age dependency ratio. A similar transformation is done with the formula for the β-effect, which is rearranged to replace PWA(t+1) − PWA(t) with equation 2) (see Appendix Equation 2 for the step-by-step substitution). The four right-hand terms of equation 7) denote the effects of cohort turnover as the difference between the number of individuals entering and leaving the working-age population, deaths in the working-age population, net migration in the working-age population and changes in life expectancy on the denominator of the prospective old-age dependency ratio:

$$7)\ \beta\text{-effect} = \left[-\frac{1}{2} * \frac{POA(t+1)+POA(t)}{PWA(t+1)*PWA(t)} * CT_{PWA}(t)\right] + \left[\frac{1}{2} * \frac{POA(t+1)+POA(t)}{PWA(t+1)*PWA(t)} * D_{PWA}(t)\right] + \left[-\frac{1}{2} * \frac{POA(t+1)+POA(t)}{PWA(t+1)*PWA(t)} * M_{PWA}(t)\right] + \left[\frac{1}{2} * \frac{POA(t+1)+POA(t)}{PWA(t+1)*PWA(t)} * CT_{LEchange}(t)\right]$$

Finally, the effects by component (CT, D, M, $CT_{LEchange}$) are obtained by summing the α- and β-effects by component from equations 6) and 7). The decomposition analysis is performed for the entire period from 1990 to 2020 and separately by decade to illustrate changes over time.

3 Results

3.1 Population ageing 1990-2020

The level of population ageing varies substantially across Asian countries. For instance, the countries of the Gulf Cooperation Council (GCC) – Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates – have an extremely young age structure, while Japan has one of the oldest populations in the world (*Sanderson/Scherbov* 2008). However, in countries with high life expectancy, such as Japan, population ageing seems less dramatic when using prospective measures. Table 1 shows the prospective old-age threshold (POAT), the prospective old-age dependency ratio (POADR) and the chronological old-age dependency ratio (OADR) using age 65 as the old-age threshold. The prospective old-age threshold – the age at which the average remaining life expectancy equals 15 years – ranges from age 62.1 in Afghanistan to age 74.7 in Hong Kong. In 16 of the 51 countries, the prospective old-age threshold is lower than the classical old-age threshold at age 65. Consequently, the POADR is higher than the OADR. However, in 35 countries, the prospective old-age threshold is higher than 65, leading to a lower prospective old-age dependency ratio. While the differences in the level of population ageing between countries are less pronounced when applying the prospective old-age threshold, they remain remarkable. On one hand, the GCC countries exhibit the world's lowest prospective old-age dependency ratios, ranging from 0.7 percent (Qatar) to 2.9 percent (Kuwait). However, low or relatively low prospective old-age dependency ratios are not found solely in Western Asia, but also in other subregions, e.g. in Macao (5.5 percent), the Maldives (4.2 percent), Singapore (5.6 percent) and Afghanistan (6.1 percent). On the other hand, Japan and Georgia reach high values of 23.0 percent and 22.2 percent respectively, ranking them among the world's most aged countries (*UN DESA* 2022b, own calculations). Following these two exceptional countries, other countries with higher prospective old-age dependency ratios are spread over all subregions, such as Armenia (15.6 percent), Kazakhstan (14.1 percent), Myanmar (12.2 percent), North Korea (13.4 percent) and Sri Lanka (13.2 percent).

The age structure of Asian countries has also evolved quite differently in recent decades. In 27 of the 51 countries, population ageing – measured by an increase in the prospective old-age dependency ratio – has advanced between 1990 and 2020. Japan stands out with an increase of more than eleven percentage points (Fig. 1), followed by Georgia (+7.0 percentage points), North Korea (+6.1 percentage points), Armenia (+6.1 percentage points) and Sri Lanka (+5.0 percentage points). Globally, only about 20 countries – mainly in Europe and the Caribbean – have experienced comparable increases in the prospective old-age dependency ratio during this period (*UN DESA* 2022b, own calculations), underlining the notable speed of population ageing in some Asian countries. In 24 of 51 Asian countries however, the prospective old-age dependency ratio decreased from 1990 to 2020, e.g. in Afghanistan (-4.1 percentage points), Iraq (-4.4 percentage points) and Mongolia (-4.9 percentage points). Similar declines are seen in many other countries, particularly in sub-Saharan Africa. A decreasing prospective old-age dependency ratio is not surprising

Tab. 1: Prospective old-age threshold, prospective old-age dependency ratio (POADR) and chronological old-age dependency ratio (OADR) (2020)

	Prospective old-age threshold	POADR	OADR
Central Asia			
Kazakhstan	63.8	14.1	12.3
Kyrgyzstan	63.9	7.9	6.9
Tajikistan	63.8	6.2	5.3
Turkmenistan	63.3	8.9	7.2
Uzbekistan	62.9	9.4	7.3
Eastern Asia			
China	68.6	11.7	17.7
Hong Kong	74.7	10.2	26.5
Japan	74.1	23.0	50.3
Macao	73.9	5.5	15.3
Mongolia	65.2	6.4	6.6
North Korea	66.9	13.4	15.7
South Korea	72.9	10.2	21.3
Taiwan	71.7	10.1	20.5
South-Eastern Asia			
Brunei Darussalam	66.2	6.3	7.4
Cambodia	65.4	7.5	7.9
Indonesia	63.8	11.2	9.9
Lao	63.0	8.2	6.6
Malaysia	66.8	8.1	9.9
Myanmar	62.5	12.2	9.3
Philippines	64.3	8.7	8.1
Singapore	73.3	5.6	16.9
Thailand	73.8	7.7	19.2
Timor-Leste	63.0	10.8	9.3
Viet Nam	68.0	8.5	12.0
Southern Asia			
Afghanistan	62.1	6.1	4.5
Bangladesh	65.8	7.6	8.3
Bhutan	64.0	9.4	8.5
India	65.9	8.9	9.8
Iran	67.4	7.8	10.1
Maldives	68.8	4.2	5.8
Nepal	63.1	11.4	9.5
Pakistan	63.1	8.7	7.1
Sri Lanka	67.0	13.2	16.2

Tab. 1: Continuation

	Prospective old-age threshold	POADR	OADR
Western Asia			
Armenia	66.4	15.6	18.2
Azerbaijan	65.1	9.1	9.2
Bahrain	69.1	2.3	4.0
Cyprus	70.6	12.1	20.0
Georgia	65.1	22.2	22.3
Iraq	64.2	6.3	5.9
Israel	72.4	9.7	19.6
Jordan	66.7	4.7	5.6
Kuwait	68.7	2.9	5.0
Lebanon	68.9	10.2	14.6
Oman	67.7	2.8	3.7
Palestine	66.2	5.3	6.0
Qatar	69.7	0.7	1.4
Saudi Arabia	68.0	2.3	3.2
Syria	65.0	7.5	7.5
Turkey	68.2	8.6	11.9
United Arab Emirates	69.2	1.3	1.9
Yemen	62.8	5.9	4.8

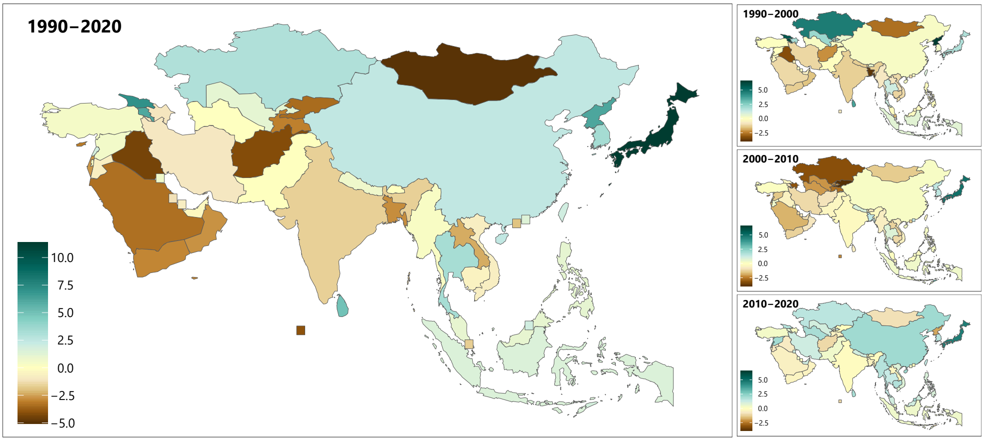
Notes: Prospective old-age threshold: Age at which the average remaining life expectancy equals 15 years.

Source: *UN DESA* 2022b, own calculations.

at an earlier stage of population ageing, even though the chronological old-age dependency ratio might already be increasing at the same time (*Sanderson/Scherbov* 2008).

An examination of the changes in the prospective old-age dependency ratio by decade (Fig. 1) indicates that in most of the Asian countries with an overall decline, the negative trend has either diminished over time, e.g. in India, or even shifted towards an increase in the 2010s, e.g. in Iran. A distinct development emerges in Kazakhstan and Uzbekistan. In these Central Asian countries, the prospective old-age dependency ratio rose sharply in the 1990s and declined in the 2000s before increasing again in the last decade. Also in Armenia and Georgia (Western Asia), remarkable increases in the prospective old-age dependency ratio have been observed during the 1990s. As the following decomposition analysis reveals, this development is partly due to migration.

Fig. 1: Change in the prospective old-age dependency ratio (1990-2020) (in percentage points)



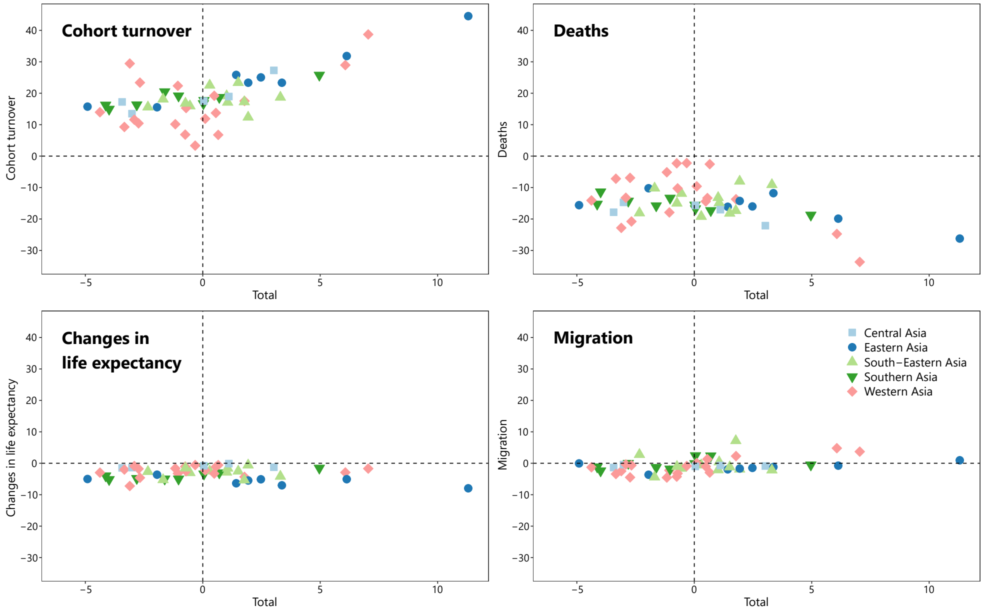
Map Source: *Minnesota Population Center* 2020.
Source: *UN DESA* 2022b, own calculations.

3.2 Drivers of population ageing 1990-2020

Turning towards the drivers of the age-structure changes illustrated above,Figure 2 depicts the total change in the prospective old-age dependency ratio (x-axis) and the change due to cohort turnover, deaths, changes in life expectancy and migration (y-axis) over the period 1990-2020. Detailed values by country are reported in Appendix Table A2. In general, cohort turnover and deaths had a larger impact on the prospective old-age dependency ratio than changes in life expectancy and migration. The effect of *cohort turnover*, driven mainly by growing cohorts entering old-age, is positive in all countries. The largest effects are found in Georgia (+38.7 percentage points) and Japan (+44.5 percentage points), indicating an age structure increasingly dominated by older cohorts. Conversely, the effect of cohort turnover is smaller in countries with younger age structures and larger cohorts entering working-age. This is the case in countries with still relatively high fertility rates, e.g. Palestine (+11.9 percentage points) and Yemen (+11.6 percentage points), as well as in the GGC countries where the age structure is skewed towards working-age due to labour migration. The smallest effect is observed in the United Arab Emirates (+3.3 percentage points).

While cohort turnover accelerated population ageing, *deaths* consistently yielded a decelerating impact on population ageing across all countries. This is because mortality happens predominantly at older ages and less at working-age, consequently reducing the prospective old-age dependency ratio. As with the cohort turnover effect, this effect is most pronounced in Georgia (-33.7 percentage points) and Japan (-26.2 percentage points) and least pronounced in the GCC countries, such as the United Arab Emirates (-2.2 percentage points). These differences arise because the

Fig. 2: Total change in the prospective old-age dependency ratio and change by component (1990-2020) (in percentage points)



Source: *UN DESA* 2022b, own calculations.

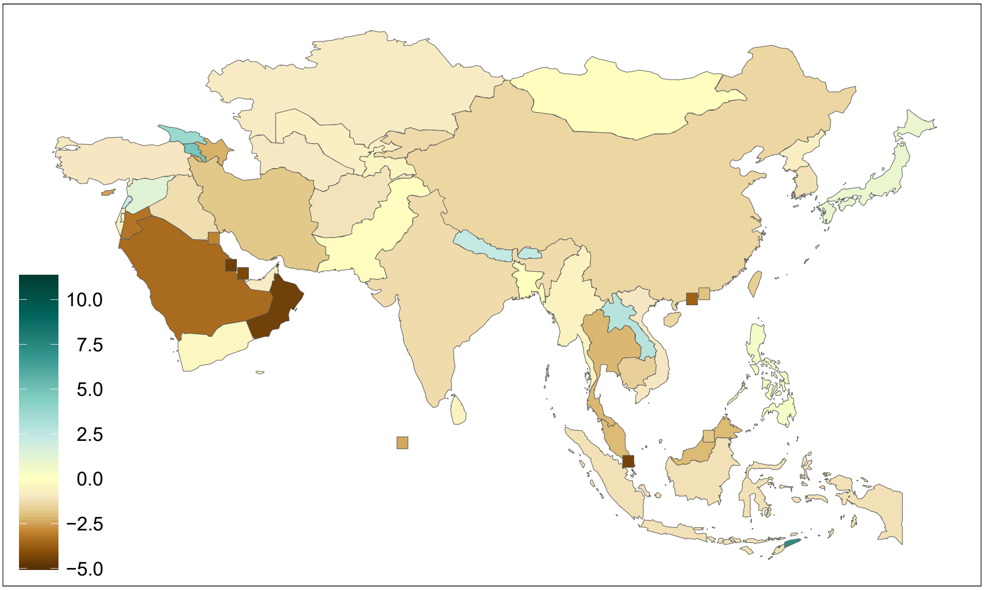
number of deaths by age group – and consequently the effect of deaths on the prospective old-age dependency ratio – is not only determined by the age-specific death rates, but also depends heavily on the age structure (see *Liang et al.* 2023). This can be illustrated by applying the age structure of the United Arab Emirates in 1990, which was the youngest in that year, to all countries. The standardized number of deaths in all countries – except the United Arab Emirates of course – is lower than the actual number of deaths observed in 1990. In Qatar and Kuwait, only about 5 percent of deaths in 1990 can be attributed to the slightly older age structure of these countries compared with the United Arab Emirates 1990 standard (results not shown here). In Japan, however, this percentage reaches 81 percent, indicating the large impact of Japan's old age structure on the number of deaths. These examples underline that the effect of deaths on the prospective old-age dependency ratio reflects to a large part the country-specific age distribution.

The effect of *changes in life expectancy* on the prospective old-age dependency ratio is determined by changes in the prospective old-age threshold. With the exception of Uzbekistan, where the prospective old-age threshold in 2020 was at about the same level as in 1990, it increased in all Asian countries between 1990 and 2020 (Appendix Table A1). Consequently, this led to a reduction in the age groups defined as the old-age population and resulted in a negative effect of changes in life expectancy on the prospective old-age dependency ratio (Fig. 2). The effect is most pronounced in countries with large improvements in life expectancy, particularly in Eastern Asia (e.g. Hong Kong and South Korea). In South Korea, for instance, the prospective old-age threshold increased over the three decades from age 65.3 to age 72.9, which in turn decreased the prospective old-age dependency ratio by seven percentage points (Appendix Table A2). Conversely, the effect is smaller in countries with minor differences in the prospective old-age threshold, e.g. in the Central Asian countries Turkmenistan and Uzbekistan. In Qatar and other GCC countries in Western Asia, the impact also remains modest despite noticeable improvements in life expectancy. This is again due to their particularly young population. Since the effect of changes in life expectancy also depends on the number of individuals potentially affected by a shift in the old-age threshold, the small cohort sizes at these ages reduce the effect of increasing old-age thresholds on the prospective old-age dependency ratio.

Turning towards the impact of migration, both a decelerating and an accelerating effect on population ageing can be found in Asian countries (Fig. 2). A decelerating effect is due to positive net migration at working-age and/or negative net migration at old-age, while an accelerating effect is based on the opposite patterns. Despite the migration effect being smaller than the effect of deaths and cohort turnover in most countries, migration had a notable impact on population ageing in some countries over the last three decades. Figure 3 shows how migration has contributed to changes in the prospective old-age dependency ratio from 1990 to 2020. On one hand, large negative effects are observed in high-immigration countries, e.g. in Bahrain (-4.5 percentage points), Macao (-3.6 percentage points), Oman (-4.5 percentage points) and Singapore (-4.4 percentage points). In these countries, the prospective old-age dependency ratio would have increased without migration, illustrating that migration has not only slowed down but halted the process of population ageing. This migration effect is driven largely by high net migration at working-age (results not shown here), which aligns with the higher intensity of migration among younger adults. On the other hand, the largest positive effects of migration on the prospective old-age dependency ratio are found in Armenia (+4.8 percentage points), Georgia (+3.7 percentage points) and Timor-Leste (+7.2 percentage points). All three countries are characterized by high negative net migration rates (Appendix Table A6). While in Timor-Leste this migration effect was largely offset by other factors, particularly substantial improvements in life expectancy (Appendix Table A2), migration remained a pivotal driver of rapid population ageing in Armenia and Georgia.

As the above examples illustrate, differences in population ageing, at least between some high-immigration and high-emigration countries, are substantially driven by migration. In most Asian countries, however, the impact of migration on population ageing was relatively small. For instance, in Japan, which experienced the largest increase in the prospective old-age dependency ratio between 1990 and 2020, the effect of slightly positive net migration rates on the rapidly advancing ageing process was marginal. But even in countries with remarkable emigration flows, such as Bangladesh, India and the Philippines (*Abel et al.* 2019), the migration effect is small. This may be attributed to temporary migration, which is a common pattern in Asia (*Hugo* 2012). This analysis captures the effect of net migration over the entire

Fig. 3: Change in the prospective old-age dependency ratio due to migration (1990-2020) (in percentage points)



Map Source: *Minnesota Population Center* 2020.
Source: *UN DESA* 2022b, own calculations.

period under examination. For instance, a person leaving the country at working-age contributes to a positive effect on the old-age dependency ratio in the year of emigration. If this person returns before reaching old-age, the effect in the year of return is negative. The opposite effects are observed in the destination country. In general, if immigration and emigration occur in different years but within the same age group, the effects of immigration and emigration balance out over time. Since this analysis relies on population changes between two consecutive years, it does not capture short-term, seasonal mobility within the same year. However, temporary migrants from South-Eastern Asia typically stay in destination countries for several years (*Bossavie et al*. 2021; *Valenta et al*. 2020). Nevertheless, they may remain unregistered and migration flows may not be fully captured in the UN population data. In general, data on net migration by age group, derived as a residual from population and vital statistics, depend on the quality of the underlying data. In this analysis, negative migration effects on the prospective old-age dependency ratio emerge in China and India, suggesting positive net migration at working-age and/or negative net migration at old-age. However, this seems unlikely given the slightly negative net migration rates in both countries, which are mainly driven by high emigration in young adult ages (*Shen et al*. 2024). Rather, these effects may be related to inaccuracies in the underlying data on population by age and age-specific deaths. For instance, death registration rates in both countries are lower than in most developed countries (*Karlinsky* 2024). An under-reporting of deaths in old-age may lead to lower net migration in this age group, also impacting the overall migration effect on population ageing.

The impact of cohort turnover, deaths, changes in life expectancy and migration on the prospective old-age dependency ratio varies over time. The results of the decomposition by decade are reported in the Appendix (Table A3-5).[6] In all countries, *cohort turnover* had a consistently positive effect and *deaths* a consistently negative effect on the POADR. However, the impact of cohort turnover and deaths has increased in most countries towards the last decade, indicating an increasing shift towards older age structures. This is particularly true for rapidly ageing countries such as Japan, while in countries with a younger age structure, such as the United Arab Emirates, the impact of these components remains stable or even decreases slightly over the decades.

While the effect of *changes in life expectancy* over the entire period 1990-2020 is negative in all countries, reflecting improvements in life expectancy, the analysis by decade reveals that this trend is not uniformly linear in all countries. In some countries, temporary decreases in life expectancy are observed, leading to positive effects of changes in life expectancy on the POADR. The reversal of the effect of changes in life expectancy in many Western and Central Asian countries in the 1990s is particularly striking. The post-Soviet countries were strongly affected by the political, economic and social upheavals of the transformation phase. In most former Soviet republics, life expectancy declined in the 1990s before gradually recovering (*UN DESA* 2022b; *Duthé et al.* 2017; *Grigoriev et al.* 2014). This accelerated – at least temporarily – population ageing in the 1990s. In Kazakhstan, about 51 percent (+2.4 of +4.6 percentage points) of the increase in the prospective old-age dependency ratio between 1990 and 2000 can be attributed to declining life expectancy. Similar effects can be observed in North Korea (+2.6 percentage points), where life expectancy fell sharply in the 1990s due to famine and political mismanagement (*Spoorenberg/Schwekendiek* 2012). More recently, the Syrian civil war after 2011 led to a temporary decline in life expectancy. However, life expectancy and the prospective old-age threshold recovered rapidly, so that the effect of these changes on the POADR in the 2010s remains small (+0.1 percentage points).

There is also considerable variation over time in the impact of *migration* on age-structure changes. International migration flows within, from and to Asia are driven by various cultural, demographic, economic, educational, historical as well as conflict- and network-related factors (*Abel et al.* 2019). In addition, migration policies and legal frameworks play an important role in shaping migration (*de Haas et al.* 2019). Because all of these factors are subject to change, net migration rates vary over time in many countries (Appendix Table A6). Figure 4 shows net migration rates from 1990 to 2019 for three selected countries: Armenia, Syria and

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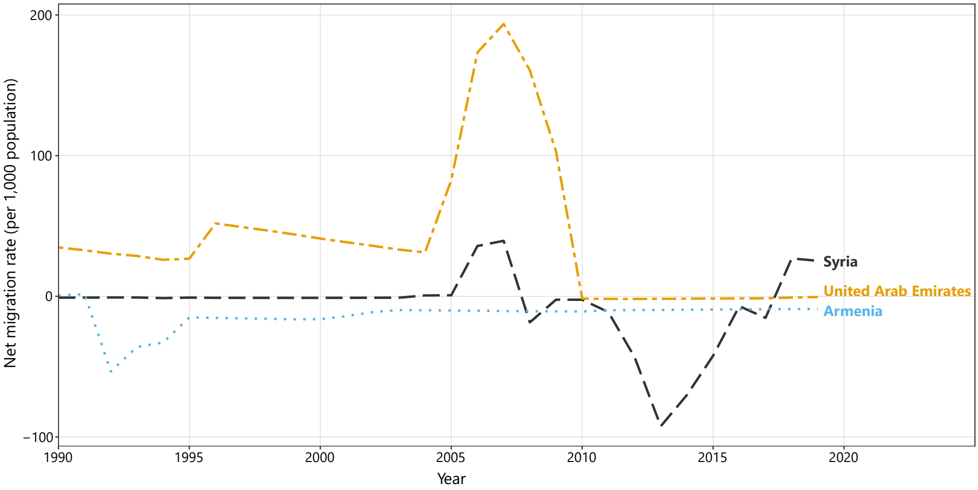
6 The sum of each of the four effects over the decades does not necessarily equal the corresponding effect calculated for the entire period 1990-2020, since the effect size depends on the changes in the size of the population by age group over the period under consideration, which in most cases follow a non-linear pattern.

Fig. 4: Net migration rate for selected countries (1990-2019) (per 1,000 population)



Source: *UN DESA* 2022b.

the United Arab Emirates. Net migration rates in the United Arab Emirates reached a pronounced peak around 2005 to 2009, followed by a significant decline associated with the lower demand for labour migrants following the global economic crisis (*de Bel-Air* 2018). In the 2010s, net migration in the United Arab Emirates even turned slightly negative. As a result, the overall migration effect from 1990 to 2020 is lower in the United Arab Emirates than in other GCC countries. Migration and its impact on population ageing can also be temporarily impacted by armed conflict and displacement. In Syria, net migration rates peaked in 2006 and 2007, related to large refugee movements from neighbouring Iraq (*Lischer* 2008), and fell to negative rates with the onset of the Syrian civil war in 2011, which led to large refugee emigration (*McAuliffe/Triandafyllidou* 2021). These events had a noticeable impact on the age structure. About 56 percent (+1.1 of +2.0 percentage points) of the increase in the prospective old-age dependency ratio in Syria during the 2010s can be attributed to migration. Similar dynamics can be observed in other Asian countries affected by armed conflict, such as Afghanistan, Iraq and Timor-Leste. The downfall of the Soviet Union also had a remarkable impact on net migration in the former Soviet republics. In Armenia, for instance, emigration rose remarkably after gaining independence in 1991, contributing to the large increase in the prospective old-age dependency ratio in the 1990s. The migration effect accounted for about 35 percent (+2.8 of +6.3 percentage points) of the increase between 1990 and 2000. These examples illustrate the impact of temporary increases or declines in net migration on changes in the age structure of Asian countries.

4 Conclusion and discussion

Population ageing in Asia has evolved differently over recent decades, with some countries ageing remarkably and others maintaining a very young age structure. In this paper, I assess the impact of international migration on age-structure changes in 51 Asian countries from 1990 to 2020. To take into account varying health and life expectancy, I propose a new approach to incorporate a dynamic prospective old-age threshold into a decomposition analysis of changes in the old-age dependency ratio. The results reveal a smaller effect of migration on population ageing compared to the effects of cohort turnover and deaths. However, extraordinary migration effects are observed in some countries with either very negative or very positive net migration. As migration largely occurs at younger ages, high immigration had a decelerating effect on population ageing, and high emigration an accelerating effect. Hence, the large differences in the speed and level of population ageing across Asian countries can be partly attributed to migration.

The findings reflect both the evolution and variation of migration policies as well as geopolitical and economic changes that have influenced migration patterns since 1990. Economic growth and policies promoting temporary labour migration in the countries of the Gulf Cooperation Council (*Aarthi/Sahu* 2021) led to high immigration flows at working-age, which slowed down or even halted the process of population ageing. Other economically strong countries, such as South Korea, remained relatively closed to immigration due to predominantly restrictive migration policies (*de Haas et al.* 2018), so that almost no such decelerating effect of migration on population ageing was observed. Yet, countries like Japan and South Korea are increasingly making efforts to open up to more immigration, also driven by the demographic challenges posed by an ageing population (*de Haas et al.* 2018; *Oishi* 2021). Finally, the dissolution of the Soviet Union accelerated emigration from former Soviet republics in the 1990s, which contributed to faster-ageing populations. This effect is most pronounced in Armenia and Georgia, despite policy efforts to constrain emigration (*Makaryan/Chobanyan* 2014; *Reslow* 2017). However, both countries have recently experienced higher immigration flows, at least temporarily halting the longstanding trend of negative net migration. In Georgia, this is attributed to a rise in migration from Russia following the invasion in Ukraine in 2022 (*National Statistics Office of Georgia* 2024). In Armenia, it is driven by refugees from Azerbaijan (Nagorno-Karabakh) following the Azerbaijani offensive in Artsakh in 2023 (*Statistical Committee Republic of Armenia* 2024).

This study introduces an approach to incorporate the prospective age concept into decomposition analyses of age-structure changes. Prospective age takes into account differences in life expectancy – as a proxy for additional characteristics beyond chronological age – thus providing a more comprehensive picture of population ageing. Although the impact of changes in life expectancy on the old-age dependency ratio remains modest compared to the effects of cohort turnover and deaths, the application of prospective age in the decomposition of age-structure changes increases comparability across different contexts. Further studies using the approach presented in this paper may yield valuable insights into the drivers behind age-structure changes in other world regions and countries applying the prospective view of population ageing. Prospective age is calculable for all countries, making it a very useful measure for such comparative analyses. It should be noted, however, that country-level analyses do not consider health differences across population subgroups. For example, it is well known that education is strongly correlated with higher (healthy) life expectancy (*Weber/Loichinger* 2022). Moreover, the actual expected lifetime and prospective old-age threshold may be underestimated based on period life expectancy, making population ageing appear slightly more pronounced compared to when using cohort life expectancy (*Kjærgaard/Canudas-Romo* 2017).

The analyses in this study are based on estimates from the UN World Population Prospects 2022, which provide a unique source of population data for all Asian countries. However, the quality of the UN data depends on the national data available and are subject to uncertainties, particularly in countries without longstanding high-quality vital registration systems (*Liu/Raftery* 2020). In Asia, death registration is incomplete in most countries (*Karlinsky* 2024). In addition, temporary and undocumented migration flows may not be captured in official statistics (*Raymer et al.* 2022), which might also impact population counts. In general, data on international migration, particularly by age, are scarce (*Willekens et al.* 2016). In this study, net migration by age group is derived from population and death counts (*Siegel/Hamilton* 1952). Since this method does not require data on migrant stocks or flows, it can be applied even in cases of poor data availability (*UN DESA* 2022a). However, the derived net migration is still subject to uncertainty, as it depends on the quality of vital statistics and population counts. Therefore, the results should be interpreted with caution, acknowledging the uncertainties in the underlying data.

Another limitation arises from the decomposition method used in this study, as it captures only the direct effect of net migration on the age structure, without accounting for potential indirect or long-term demographic effects. This is because migrants contribute to the migration effect on population ageing only in the year of migration. In subsequent years, they become part of the total population of the country of residence. As a result, they may potentially contribute to cohort turnover and deaths (and again to the migration effect). In addition to these effects, migrants can also contribute to age-structure changes through fertility in the long term (*Goldstein* 2009). Given that the fertility of temporary labour migrants, who make up a large share of migrants in Asia, is usually lower in the destination countries, the long-term effect of immigration through births can be assumed to be lower in many Asian countries than in the European context (see *Fihel et al*. 2018; *Murphy* 2017). Yet, in some Asian countries, such as Armenia and Georgia, the emigration of younger adults has had a remarkable impact on the number of births (*Weinar* 2014), affecting the age structure in the long run.

While population ageing seems less dramatic through the lens of prospective age, it remains a key issue for development in Asia. However, as this study underlines, there is substantial demographic heterogeneity across countries. In addition, the level and speed of population ageing also varies remarkably within Asian countries (*Gietel-Basten et al.* 2016). These differences may be related to internal and international migration. In many Asian countries, rural-urban migration is a notable phenomenon (*Bell et al.* 2020). Moreover, international migration patterns also vary between urban and rural areas (*Hugo* 2016). Future studies could further explore the impact of both international and internal migration on regional age-structure changes, enhancing our understanding of the relationship between migration and population ageing in Asian countries.

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Appendix

Step-by-step substitution of POADR(t+1) – POADR(t) = α-effect + β-effect (cf. equation 5) in section Data and methods) into the α-effects and β-effects by component:

1) α-effect =

$$\left[\frac{1}{2} * \left(\text{POA(t+1)} - \text{POA(t)}\right) * \left(\frac{1}{\text{PWA(t+1)}} + \frac{1}{\text{PWA(t)}}\right)\right] =$$

$$\left[\frac{1}{2} * \left(\text{CT}_{\text{POA}}(\text{t}) - \text{D}_{\text{POA}}(\text{t}) + \text{M}_{\text{POA}}(\text{t}) + \text{CT}_{\text{LEchange}}(\text{t})\right) * \left(\frac{1}{\text{PWA(t+1)}} + \frac{1}{\text{PWA(t)}}\right)\right] =$$

$$\left[\frac{1}{2} * \left(\frac{1}{\text{PWA(t+1)}} + \frac{1}{\text{PWA(t)}}\right) * \text{CT}_{\text{POA}}(\text{t})\right] +$$

$$\left[-\frac{1}{2} * \left(\frac{1}{\text{PWA(t+1)}} + \frac{1}{\text{PWA(t)}}\right) * \text{D}_{\text{POA}}(\text{t})\right] +$$

$$\left[\frac{1}{2} * \left(\frac{1}{\text{PWA(t+1)}} + \frac{1}{\text{PWA(t)}}\right) * \text{M}_{\text{POA}}(\text{t})\right] +$$

$$\left[\frac{1}{2} * \left(\frac{1}{\text{PWA(t+1)}} + \frac{1}{\text{PWA(t)}}\right) * \text{CT}_{\text{LEchange}}(\text{t})\right]$$

2) β-effect =

$$\left[\frac{1}{2} * \left(\text{POA(t+1)} + \text{POA(t)}\right) * \left(\frac{1}{\text{PWA(t+1)}} - \frac{1}{\text{PWA(t)}}\right)\right] =$$

$$\left[\frac{1}{2} * \left(\text{POA(t + 1)} + \text{POA(t)}\right) * \left(\frac{\text{PWA(t)} - \text{PWA(t+1)}}{\text{PWA(t+1)} * \text{PWA(t)}}\right)\right] =$$

$$\left[\frac{1}{2} * \left(\frac{\text{POA(t+1)} + \text{POA(t)}}{\text{PWA(t+1)} * \text{PWA(t)}}\right) * \left(\text{PWA(t)} - \text{PWA(t+1)}\right)\right] =$$

$$\left[-\frac{1}{2} * \left(\frac{\text{POA(t+1)} + \text{POA(t)}}{\text{PWA(t+1)} * \text{PWA(t)}}\right) * \left(\text{PWA(t+1)} - \text{PWA(t)}\right)\right] =$$

$$\left[-\frac{1}{2} * \left(\frac{\text{POA(t+1)} + \text{POA(t)}}{\text{PWA(t+1)} * \text{PWA(t)}}\right) * \left(\text{CT}_{\text{PWA}}(\text{t}) - \text{D}_{\text{PWA}}(\text{t}) + \text{M}_{\text{PWA}}(\text{t}) - \text{CT}_{\text{LEchange}}(\text{t})\right)\right] =$$

$$\left[-\frac{1}{2} * \frac{\text{POA(t+1)} + \text{POA(t)}}{\text{PWA(t+1)} * \text{PWA(t)}} * \text{CT}_{\text{PWA}}(\text{t})\right] +$$

$$\left[\frac{1}{2} * \frac{\text{POA(t+1)} + \text{POA(t)}}{\text{PWA(t+1)} * \text{PWA(t)}} * \text{D}_{\text{PWA}}(\text{t})\right] +$$

$$\left[-\frac{1}{2} * \frac{\text{POA(t+1)} + \text{POA(t)}}{\text{PWA(t+1)} * \text{PWA(t)}} * \text{M}_{\text{PWA}}(\text{t})\right] +$$

$$\left[\frac{1}{2} * \frac{\text{POA(t+1)} + \text{POA(t)}}{\text{PWA(t+1)} * \text{PWA(t)}} * \text{CT}_{\text{LEchange}}(\text{t})\right]$$

Tab. A1: Prospective old-age threshold and prospective old-age dependency ratio (1990 and 2020)

	Prospective old-age threshold		Prospective old-age dependency ratio	
	1990	2020	1990	2020
Central Asia				
Kazakhstan	62.8	63.8	11.1	14.1
Kyrgyzstan	62.3	63.9	11.3	7.9
Tajikistan	62.1	63.8	9.2	6.2
Turkmenistan	62.3	63.3	8.9	8.9
Uzbekistan	62.9	62.9	8.3	9.4
Eastern Asia				
China	63.5	68.6	9.3	11.7
Hong Kong	68.2	74.7	8.8	10.2
Japan	69.3	74.1	11.7	23.0
Macao	67.9	73.9	7.5	5.5
Mongolia	59.3	65.2	11.3	6.4
North Korea	63.6	66.9	7.3	13.4
South Korea	65.3	72.9	6.8	10.2
Taiwan	65.8	71.7	8.1	10.1
South-Eastern Asia				
Brunei Darussalam	64.6	66.2	4.4	6.3
Cambodia	61.4	65.4	8.1	7.5
Indonesia	61.5	63.8	9.7	11.2
Lao	60.1	63.0	10.5	8.2
Malaysia	63.6	66.8	7.1	8.1
Myanmar	60.3	62.5	11.9	12.2
Philippines	62.4	64.3	7.6	8.7
Singapore	65.5	73.3	7.3	5.6
Thailand	68.8	73.8	4.4	7.7
Timor-Leste	57.3	63.0	9.0	10.8
Viet Nam	65.9	68.0	9.2	8.5
Southern Asia				
Afghanistan	57.5	62.1	10.2	6.1
Bangladesh	60.1	65.8	10.4	7.6
Bhutan	60.2	64.0	9.4	9.4
India	60.9	65.9	10.5	8.9
Iran	61.9	67.4	8.8	7.8
Maldives	61.4	68.8	8.2	4.2
Nepal	60.1	63.1	10.7	11.4
Pakistan	62.2	63.1	8.7	8.7
Sri Lanka	66.8	67.0	8.2	13.2

Tab. A1: Continuation

	Prospective old-age threshold		Prospective old-age dependency ratio	
	1990	2020	1990	2020
Western Asia				
Armenia	63.7	66.4	9.5	15.6
Azerbaijan	61.9	65.1	10.2	9.1
Bahrain	64.6	69.1	3.5	2.3
Cyprus	64.5	70.6	15.3	12.1
Georgia	63.8	65.1	15.2	22.2
Iraq	60.5	64.2	10.7	6.3
Israel	68.0	72.4	12.4	9.7
Jordan	63.5	66.7	5.4	4.7
Kuwait	65.8	68.7	2.2	2.9
Lebanon	63.3	68.9	8.4	10.2
Oman	63.4	67.7	5.5	2.8
Palestine	63.0	66.2	5.2	5.3
Qatar	65.2	69.7	1.5	0.7
Saudi Arabia	63.0	68.0	5.6	2.3
Syria	63.4	65.0	6.9	7.5
Turkey	64.7	68.2	8.1	8.6
United Arab Emirates	64.6	69.2	1.6	1.3
Yemen	61.4	62.8	8.8	5.9

Notes: Prospective old-age threshold in years; Prospective old-age dependency ratio in %.
Source: *UN DESA* 2022b, own calculations.

Tab. A2: Total change in the prospective old-age dependency ratio and change by component (1990-2020) (in percentage points)

	Total	Cohort turnover	Deaths	Life expectancy changes	Migration
Central Asia					
Kazakhstan	3.0	27.3	-22.1	-1.3	-0.9
Kyrgyzstan	-3.4	17.2	-17.8	-1.5	-1.4
Tajikistan	-3.0	13.5	-14.7	-1.4	-0.4
Turkmenistan	0.0	17.5	-15.7	-0.8	-1.0
Uzbekistan	1.1	18.9	-17.0	-0.1	-0.7
Eastern Asia					
China	2.5	25.0	-16.0	-5.1	-1.5
Hong Kong	1.4	25.8	-16.1	-6.4	-1.9
Japan	11.3	44.5	-26.2	-8.0	1.0
Macao	-1.9	15.5	-10.2	-3.6	-3.6
Mongolia	-4.9	15.7	-15.6	-5.0	0.0
North Korea	6.1	31.8	-19.9	-5.1	-0.8
South Korea	3.4	23.3	-11.8	-7.0	-1.2
Taiwan	1.9	23.4	-14.3	-5.5	-1.7
South-Eastern Asia					
Brunei Darussalam	1.9	12.4	-8.0	-0.6	-1.9
Cambodia	-0.5	16.0	-11.9	-3.0	-1.6
Indonesia	1.5	23.4	-18.2	-2.5	-1.2
Lao	-2.3	15.6	-18.1	-2.6	2.8
Malaysia	1.0	19.2	-13.2	-2.9	-2.1
Myanmar	0.3	22.5	-19.2	-2.5	-0.6
Philippines	1.1	17.1	-14.9	-1.6	0.4
Singapore	-1.7	18.1	-10.2	-5.2	-4.4
Thailand	3.3	18.7	-9.1	-4.2	-2.2
Timor-Leste	1.8	17.3	-17.3	-5.3	7.2
Viet Nam	-0.7	16.8	-15.0	-1.5	-1.0
Southern Asia					
Afghanistan	-4.1	16.2	-15.3	-4.0	-1.1
Bangladesh	-2.8	16.3	-14.3	-4.8	0.0
Bhutan	0.1	17.7	-16.7	-3.4	2.4
India	-1.6	20.5	-15.8	-5.0	-1.3
Iran	-1.0	19.1	-13.3	-5.0	-1.8
Maldives	-4.0	14.9	-11.4	-5.2	-2.4
Nepal	0.7	18.7	-17.3	-3.0	2.4
Pakistan	0.0	16.7	-15.6	-1.0	-0.1
Sri Lanka	5.0	25.8	-18.7	-1.5	-0.5

Tab. A2: Continuation

	Total	Cohort turnover	Deaths	Life expectancy changes	Migration
Western Asia					
Armenia	6.1	29.0	-24.8	-2.9	4.8
Azerbaijan	-1.1	22.4	-17.9	-3.3	-2.2
Bahrain	-1.2	10.2	-5.1	-1.6	-4.5
Cyprus	-3.1	29.4	-22.8	-7.2	-2.5
Georgia	7.0	38.7	-33.7	-1.7	3.7
Iraq	-4.4	14.0	-14.1	-3.0	-1.3
Israel	-2.7	23.4	-20.8	-4.6	-0.6
Jordan	-0.7	15.3	-10.3	-2.5	-3.2
Kuwait	0.7	6.8	-2.6	-0.6	-3.0
Lebanon	1.8	17.5	-13.7	-4.3	2.3
Oman	-2.7	10.4	-6.9	-1.8	-4.5
Palestine	0.1	11.9	-9.6	-2.2	0.1
Qatar	-0.7	6.8	-2.3	-1.0	-4.3
Saudi Arabia	-3.3	9.3	-7.2	-2.0	-3.4
Syria	0.6	13.7	-13.3	-1.1	1.3
Turkey	0.5	19.2	-14.4	-3.3	-1.0
United Arab Emirates	-0.3	3.3	-2.2	-0.6	-0.9
Yemen	-2.9	11.6	-13.2	-0.9	-0.4

Source: *UN DESA* 2022b, own calculations.

Tab. A3: Total change in the prospective old-age dependency ratio and change by component (1990-2000) (in percentage points)

	Total	Cohort turnover	Deaths	Life expectancy changes	Migration
Central Asia					
Kazakhstan	4.6	9.5	-7.4	2.4	0.2
Kyrgyzstan	0.5	6.9	-6.5	0.7	-0.6
Tajikistan	0.1	5.8	-6.1	0.7	-0.3
Turkmenistan	0.2	5.7	-5.2	-0.1	-0.2
Uzbekistan	2.2	6.6	-5.3	0.8	0.0
Eastern Asia					
China	0.2	7.2	-4.8	-1.9	-0.3
Hong Kong	0.1	8.5	-4.8	-2.5	-1.1
Japan	1.8	11.8	-6.4	-3.4	-0.2
Macao	-1.0	6.0	-3.5	-1.9	-1.6
Mongolia	-2.6	4.7	-6.3	-0.8	-0.2
North Korea	6.6	9.5	-4.7	2.6	-0.8
South Korea	0.3	6.1	-3.5	-1.9	-0.4
Taiwan	0.9	7.5	-4.1	-2.1	-0.4
South-Eastern Asia					
Brunei Darussalam	-0.3	3.0	-2.4	-0.6	-0.4
Cambodia	-1.2	4.6	-3.9	-0.8	-1.1
Indonesia	0.7	7.0	-5.2	-0.6	-0.4
Lao	-0.8	4.5	-5.3	-0.6	0.5
Malaysia	-0.1	4.9	-3.8	-0.6	-0.7
Myanmar	-0.8	6.2	-6.2	-0.8	0.0
Philippines	-0.1	4.5	-4.3	-0.7	0.4
Singapore	-1.7	6.0	-3.7	-2.5	-1.5
Thailand	1.2	4.5	-2.3	0.0	-1.0
Timor-Leste	-0.4	6.7	-4.9	-3.6	1.4
Viet Nam	-1.1	4.9	-4.6	-1.0	-0.3
Southern Asia					
Afghanistan	-2.2	5.1	-4.4	-2.3	-0.6
Bangladesh	-3.8	4.8	-4.9	-3.6	-0.1
Bhutan	0.5	6.3	-4.4	-1.2	-0.2
India	-1.3	6.1	-5.3	-1.7	-0.4
Iran	-1.1	4.8	-4.3	-1.3	-0.4
Maldives	-0.6	5.3	-4.3	-2.2	0.5
Nepal	-1.3	5.5	-5.2	-1.5	-0.2
Pakistan	-0.1	5.0	-4.7	0.0	-0.3
Sri Lanka	3.7	5.5	-4.8	2.8	0.2

Tab. A3: Continuation

	Total	Cohort turnover	Deaths	Life expectancy changes	Migration
Western Asia					
Armenia	6.3	10.9	-6.9	0.1	2.2
Azerbaijan	1.9	9.6	-6.4	-0.3	-1.0
Bahrain	-0.3	3.1	-1.7	-0.7	-1.0
Cyprus	-2.5	8.5	-8.7	-2.5	0.1
Georgia	5.7	15.0	-10.3	0.4	0.5
Iraq	-3.2	3.5	-4.9	-1.4	-0.4
Israel	-0.4	7.6	-7.1	-1.2	0.2
Jordan	-0.3	3.9	-2.8	-0.5	-0.8
Kuwait	-0.5	1.7	-0.8	-0.2	-1.1
Lebanon	-0.4	5.8	-4.3	-1.7	-0.2
Oman	-1.5	3.1	-2.6	-0.9	-1.1
Palestine	-0.2	3.2	-2.6	-0.5	-0.3
Qatar	0.0	2.0	-0.7	-0.1	-1.1
Saudi Arabia	-1.1	3.1	-2.8	-0.7	-0.6
Syria	0.0	3.9	-3.7	0.0	-0.1
Turkey	0.1	5.3	-4.5	-0.4	-0.3
United Arab Emirates	-0.5	1.3	-0.7	-0.2	-0.9
Yemen	-1.3	3.7	-4.4	-0.6	-0.1

Source: *UN DESA* 2022b, own calculations.

Tab. A4: Total change in the prospective old-age dependency ratio and change by component (2000-2010) (in percentage points)

	Total	Cohort turnover	Deaths	Life expectancy changes	Migration
Central Asia					
Kazakhstan	-3.2	6.9	-8.6	-1.2	-0.3
Kyrgyzstan	-3.9	2.7	-6.2	-0.4	0.0
Tajikistan	-2.6	1.8	-4.6	-0.4	0.5
Turkmenistan	-2.0	3.2	-4.9	-0.4	0.0
Uzbekistan	-2.1	3.3	-5.3	-0.3	0.2
Eastern Asia					
China	0.2	6.7	-4.9	-1.5	-0.1
Hong Kong	1.4	8.5	-4.9	-1.9	-0.4
Japan	5.0	14.7	-7.9	-2.1	0.3
Macao	-1.4	4.1	-3.0	-1.0	-1.6
Mongolia	-1.4	3.9	-4.7	-1.0	0.5
North Korea	1.4	12.6	-7.5	-3.5	-0.2
South Korea	1.5	8.2	-3.7	-2.8	-0.2
Taiwan	-0.4	7.0	-4.5	-2.1	-0.7
South-Eastern Asia					
Brunei Darussalam	0.3	3.2	-2.2	-0.2	-0.6
Cambodia	-1.1	3.6	-3.2	-1.3	-0.1
Indonesia	0.4	6.9	-5.6	-0.8	-0.2
Lao	-1.2	4.0	-5.8	-0.9	1.5
Malaysia	0.1	5.2	-3.8	-1.0	-0.3
Myanmar	-0.6	6.2	-6.1	-0.6	-0.1
Philippines	0.2	4.6	-4.5	-0.3	0.4
Singapore	-0.4	5.1	-2.8	-1.4	-1.3
Thailand	0.8	6.2	-2.8	-2.0	-0.7
Timor-Leste	3.2	5.8	-5.2	-1.5	4.1
Viet Nam	-0.5	4.2	-4.4	-0.3	0.1
Southern Asia					
Afghanistan	-0.9	4.1	-3.8	-0.9	-0.2
Bangladesh	1.4	4.7	-4.1	0.5	0.3
Bhutan	-0.5	5.1	-5.6	-1.3	1.3
India	-0.2	5.6	-4.9	-0.7	-0.2
Iran	-1.1	4.5	-3.8	-1.3	-0.4
Maldives	-2.3	4.1	-3.3	-2.5	-0.6
Nepal	0.9	5.8	-5.0	-0.7	0.8
Pakistan	-0.3	4.8	-4.6	-0.4	-0.2
Sri Lanka	-0.6	7.8	-6.8	-1.2	-0.3

Tab. A4: Continuation

	Total	Cohort turnover	Deaths	Life expectancy changes	Migration
Western Asia					
Armenia	-0.9	6.4	-8.9	-1.3	2.9
Azerbaijan	-3.1	3.8	-5.8	-0.9	-0.2
Bahrain	-1.2	2.4	-1.3	-0.6	-1.7
Cyprus	-2.1	8.3	-6.7	-2.7	-1.0
Georgia	-0.3	10.2	-12.1	-1.2	2.8
Iraq	-0.5	3.9	-4.1	0.1	-0.3
Israel	-1.7	6.8	-6.4	-2.2	0.1
Jordan	0.4	3.9	-2.7	-0.6	-0.2
Kuwait	0.0	1.9	-0.9	-0.2	-0.9
Lebanon	-1.1	4.7	-3.7	-2.0	-0.1
Oman	-0.8	2.5	-2.0	-0.5	-0.8
Palestine	0.1	3.1	-2.6	-0.6	0.2
Qatar	-0.8	1.5	-0.5	-0.3	-1.4
Saudi Arabia	-1.7	2.3	-2.1	-0.6	-1.4
Syria	-1.4	3.3	-3.2	-1.0	-0.5
Turkey	0.1	5.8	-4.5	-0.9	-0.2
United Arab Emirates	-0.9	0.6	-0.4	-0.1	-1.1
Yemen	-1.2	3.1	-3.6	-0.6	-0.1

Source: *UN DESA* 2022b, own calculations.

Tab. A5: Total change in the prospective old-age dependency ratio and change by component (2010-2020) (in percentage points)

	Total	Cohort turnover	Deaths	Life expectancy changes	Migration
Central Asia					
Kazakhstan	1.5	11.5	-7.1	-2.2	-0.6
Kyrgyzstan	0.0	6.6	-4.7	-1.3	-0.6
Tajikistan	-0.4	4.9	-3.8	-1.1	-0.3
Turkmenistan	1.9	7.0	-4.3	-0.2	-0.6
Uzbekistan	1.1	7.1	-5.0	-0.4	-0.6
Eastern Asia					
China	2.0	9.9	-5.5	-1.5	-0.9
Hong Kong	0.0	7.5	-5.4	-1.7	-0.4
Japan	4.6	17.0	-11.2	-2.1	0.9
Macao	0.5	4.2	-2.8	-0.7	-0.3
Mongolia	-0.9	5.5	-3.8	-2.4	-0.2
North Korea	-1.9	8.9	-7.1	-3.9	0.1
South Korea	1.5	8.6	-4.3	-2.1	-0.6
Taiwan	1.4	8.0	-5.0	-1.1	-0.5
South-Eastern Asia					
Brunei Darussalam	2.0	5.0	-2.6	0.1	-0.6
Cambodia	1.7	5.7	-3.2	-0.5	-0.3
Indonesia	0.4	7.7	-5.9	-0.9	-0.5
Lao	-0.3	5.3	-5.3	-0.8	0.5
Malaysia	1.1	6.5	-3.9	-0.8	-0.7
Myanmar	1.6	9.0	-6.0	-1.0	-0.4
Philippines	0.9	6.3	-4.6	-0.4	-0.3
Singapore	0.4	4.9	-2.6	-1.0	-0.9
Thailand	1.3	6.6	-3.2	-1.7	-0.4
Timor-Leste	-1.0	4.8	-6.7	-0.8	1.7
Viet Nam	0.8	6.1	-4.4	-0.2	-0.6
Southern Asia					
Afghanistan	-1.1	3.2	-3.4	-0.5	-0.4
Bangladesh	-0.4	5.7	-4.2	-1.6	-0.3
Bhutan	0.1	5.8	-5.9	-0.8	1.0
India	-0.1	7.0	-4.5	-2.1	-0.6
Iran	1.2	6.8	-3.5	-1.5	-0.6
Maldives	-1.1	2.9	-2.5	-0.5	-1.1
Nepal	1.1	6.5	-5.8	-0.7	1.0
Pakistan	0.4	5.0	-4.5	-0.4	0.2
Sri Lanka	1.9	10.9	-6.2	-2.5	-0.2

Tab. A5: Continuation

	Total	Cohort turnover	Deaths	Life expectancy changes	Migration
Western Asia					
Armenia	0.7	11.2	-9.2	-1.9	0.5
Azerbaijan	0.2	7.8	-5.1	-1.6	-0.9
Bahrain	0.4	2.3	-1.1	-0.2	-0.7
Cyprus	1.5	9.8	-5.9	-1.5	-0.9
Georgia	1.7	14.9	-13.1	-1.3	1.1
Iraq	-0.7	4.5	-3.6	-1.3	-0.3
Israel	-0.5	6.7	-5.6	-0.8	-0.8
Jordan	-0.8	3.9	-2.6	-0.7	-1.4
Kuwait	1.1	3.1	-0.9	-0.2	-0.8
Lebanon	3.3	6.2	-4.3	-0.4	1.9
Oman	-0.4	3.0	-1.6	-0.3	-1.5
Palestine	0.2	3.4	-2.6	-0.7	0.0
Qatar	0.0	1.1	-0.3	-0.2	-0.5
Saudi Arabia	-0.5	2.1	-1.4	-0.4	-0.8
Syria	2.0	4.5	-3.8	0.1	1.1
Turkey	0.3	6.6	-4.4	-1.5	-0.4
United Arab Emirates	1.1	0.5	-0.3	-0.1	1.0
Yemen	-0.4	2.9	-3.3	0.2	-0.1

Source: *UN DESA* 2022b, own calculations.

Tab. A6: Mean annual net migration rates 1990-2019, 1990-1999, 2000-2009, 2010-2019 (per 1,000 population)

	1990-2019	1990-1999	2000-2009	2010-2019
Central Asia				
Kazakhstan	-6.3	-19.1	0.0	-0.1
Kyrgyzstan	-5.9	-6.7	-5.4	-6.2
Tajikistan	-5.9	-12.0	-3.8	-2.7
Turkmenistan	-1.5	-0.7	-2.0	-1.7
Uzbekistan	-1.5	-2.1	-1.5	-1.0
Eastern Asia				
China	-0.3	-0.5	-0.4	-0.1
Hong Kong	4.3	8.1	3.4	2.0
Japan	0.9	0.3	1.0	1.2
Macao	15.0	11.5	21.1	12.7
Mongolia	-2.2	-3.9	-3.8	0.7
North Korea	-0.1	-0.1	-0.1	-0.1
South Korea	-0.2	-3.7	-0.6	3.9
Taiwan	-0.2	-2.0	0.1	1.3
South-Eastern Asia				
Brunei Darussalam	2.3	4.7	3.3	-0.9
Cambodia	0.6	6.1	-1.0	-3.0
Indonesia	-0.2	0.0	-0.4	-0.2
Lao	-3.8	-3.4	-5.3	-3.0
Malaysia	5.5	5.1	8.7	3.1
Myanmar	-2.2	-1.6	-3.4	-1.7
Philippines	-1.5	-1.6	-2.3	-0.9
Singapore	15.5	19.8	17.5	10.8
Thailand	1.3	1.7	1.6	0.8
Timor-Leste	-5.9	-8.7	-6.5	-2.5
Viet Nam	-0.5	0.2	-1.6	0.0
Southern Asia				
Afghanistan	8.4	25.2	-0.5	1.0
Bangladesh	-3.1	-2.8	-5.1	-1.7
Bhutan	-4.3	-17.1	4.4	-0.9
India	-0.2	0.0	-0.4	-0.2
Iran	1.5	0.5	2.7	1.8
Maldives	8.9	-1.9	7.8	22.6
Nepal	-5.7	-2.0	-8.5	-8.8
Pakistan	-3.2	-0.6	-1.8	-7.5
Sri Lanka	-3.0	-3.7	-1.2	-3.8

Tab. A6: Continuation

	1990-2019	1990-1999	2000-2009	2010-2019
Western Asia				
Armenia	-13.3	-19.9	-11.3	-9.6
Azerbaijan	-0.6	-3.8	1.6	0.2
Bahrain	17.9	11.6	39.2	9.9
Cyprus	8.9	10.2	12.5	4.9
Georgia	-14.0	-26.3	-12.8	-4.6
Iraq	0.4	0.4	-3.9	5.2
Israel	4.3	9.2	2.4	1.5
Jordan	13.1	8.7	6.3	27.8
Kuwait	12.2	-8.3	21.5	33.3
Lebanon	0.1	-0.2	0.7	6.5
Oman	9.6	2.1	-3.8	41.3
Palestine	-4.0	1.0	-7.5	-5.8
Qatar	47.6	18.7	90.4	48.6
Saudi Arabia	5.1	4.0	9.8	4.6
Syria	-5.7	-1.0	5.1	-28.6
Turkey	0.1	-1.1	-0.6	2.5
United Arab Emirates	40.3	37.1	89.3	-1.6
Yemen	-2.3	-2.7	-3.2	-1.1

Source: *UN DESA* 2022b, own calculations.

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