# 2. Asia: At Risk of Growing Old before Becoming Rich?

## Introduction and Main Findings

In past decades, Asia has benefited significantly from demographic trends, along with strong policies. Many parts of Asia, particularly East Asia, reaped a "demographic dividend" as the number of workers grew faster than the number of dependents, providing a strong tailwind for growth. This dividend is about to end for many Asian economies. This can have important implications for labor markets, investment and saving decisions, and public budgets.

Against this backdrop, this chapter examines the implications of projected demographic changes in major Asian economies over the coming decades under three broad headings: implications for growth, external balance, and financial markets in the region.[1] Separately, the chapter briefly discusses Japan's experience with adverse demographic trends in recent decades (Box 2.1) and fiscal implications of aging for Asia (Box 2.2). The chapter concludes by presenting policy options to address some of the unique challenges arising from Asia's demographic transition.

The main findings of this chapter are:

- ***Trends.*** Asia is aging fast. The speed of aging is especially remarkable compared to the historical experience in Europe and the United States. As such, parts of Asia risk becoming old before becoming rich. The region's per capita income relative to the United States stands at much lower levels than those reached by mature advanced economies in the past. In a global context, Asia is shifting from being the biggest contributor to the global working-age population to subtracting hundreds of millions of people from it.[2]
- ***Growth.*** Asia has enjoyed a substantial demographic dividend in past decades, but rapid aging is now set to create a demographic tax on growth. Demographic trends could subtract ½ to 1 percentage point from annual GDP growth over the next three decades in post-dividend countries such as China and Japan. In contrast, they could add 1 percentage point to annual GDP growth in early-dividend countries, such as India and Indonesia, if the transition is well managed. Overall, however, demographics are likely to be slightly negative for Asian growth and could subtract 0.1 of a percentage point from annual global growth over the next three decades (or 0.2 of a percentage point if early-dividend countries are unable to reap the demographic dividend). In several Asian economies, immigration—if past trends continue—could play an important role in softening the impact of aging or prolonging the demographic dividend (Australia, Hong Kong SAR, New Zealand, and Singapore).
- ***Inflation.*** In cases in which structural excess savings and low investment due to demographics lead to such a low real neutral interest rate that monetary policy may no longer stimulate the economy, the economy may operate below potential, keeping inflation under the central bank's target (see Box 2.1 for the case of Japan). This raises the risk of Asia falling into a period of "secular stagnation" at a lower income level compared

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[1]The chapter analyzes developments in the 13 largest Asian economies: Australia, China, Hong Kong SAR, India, Indonesia, Japan, Korea, Malaysia, New Zealand, the Philippines, Singapore, Thailand, and Vietnam.

[2]Throughout this chapter, unless otherwise noted, the working-age population is defined as persons 15 to 64 years old (international definition). Youth dependency ratio refers to persons aged 14 and below as a share of the working-age population, and old-age dependency ratio to persons aged 65 and above as a share of the working-age population.

to advanced economies and smaller policy buffers.

- ***External flow balance.*** The diversity of demographic trends in the region creates opportunities for capital flows and cross-border risk sharing—that is, savings from surplus countries can be used to fulfill capital needs in younger economies. Projections based on the IMF's External Balance Approach (EBA) model suggest that, over the next decade, surpluses of some Asian economies are projected to increase due to demographics. However, the impact is material only for a small set of countries, and the overall effect on global imbalances is likely to be limited (about 0.1 of a percentage point of global GDP over the next decade).

- ***Financial markets***. Finally, demographic trends are likely to put downward pressure on real interest rates and asset returns for most major countries in Asia. These domestic effects are likely to be less important for countries that are financially open. For those, changes in the world interest rate—which may in turn be driven by global aging trends—will likely matter more.

The main policy implications of this chapter are:

- Adapting to aging could be especially challenging for Asia, as populations living at relatively low per capita income levels in many parts of the region are rapidly becoming old. In light of this, policies aimed at protecting the vulnerable elderly and prolonging strong growth take on a particular urgency in Asia.

- Given these low income levels, it is important to adapt macroeconomic policies early on before aging sets in. This may include securing debt sustainability and monitoring potential changes in monetary transmission owing to aging.

- Specific structural reforms—which fiscal space can support—can also help address these challenges. These may include labor market reforms (promoting labor force participation of women and the elderly, guest worker programs, and active labor market policies); pension reforms (automatic adjustment mechanisms and minimum pension guarantees); and retirement system reforms (new financial products to reduce precautionary savings and increase the availability of "safe assets"). These policies could be further supplemented by specific productivity-enhancing reforms (for example, through research and development and education), as discussed in Chapter 3.

## Demographic Trends in Asia

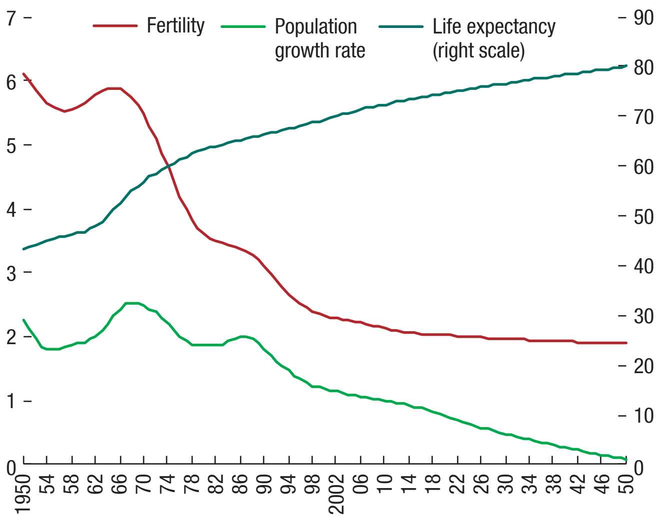
Asia is undergoing a demographic transition marked by slowing population growth and aging. This mainly reflects declining fertility rates since the late 1960s and to a lesser extent rising life expectancy (Figure 2.1). The population growth rate, already negative in Japan, is projected to fall to zero for Asia by 2050. The working-age population share is at its peak now and projected to decline over coming decades. The share of the population age 65 and older (old-age population) will increase rapidly and reach close to 2½ times the current level by 2050. East Asia, in particular, is projected to be the world's fastest-aging region in the coming decades, with its old-age dependency ratio roughly tripling by 2050.[3]

The demographic outlook varies across Asia. Broadly following the findings of World Bank (2015), three broad groups of countries can be distinguished: (1) post-dividend economies, where the working-age population is shrinking in terms of its share in the total population as well as in absolute numbers; (2) late-dividend economies, where the working-age population is declining as a share of total population, but is still growing

[3]Population projections in this chapter are based on United Nations, *World Population Prospects: 2015 Revision* (medium-fertility scenario with unchanged net migration flows). Projections do not differ much until 2030, but uncertainty increases with the projection horizon primarily due to different assumptions about future fertility rates (World Bank 2015).

**Figure 2.1. Asia: Fertility, Life Expectancy, and Population Growth**

*(Percent on left scale; year on right scale)*




Source: IMF staff estimates based on United Nations 2015 (medium-fertility scenario).

**Table 2.1. Asia: Demographic Classification**

| | Demographic Characteristics in 2015 | Projected Demographic Characteristics in 2030 |
|---|---|---|
| Australia | Late dividend | Late dividend |
| China | Post dividend | Post dividend |
| Hong Kong SAR | Post dividend | Post dividend |
| India | Early dividend | Early dividend |
| Indonesia | Early dividend | Late dividend |
| Japan | Post dividend | Post dividend |
| Korea | Post dividend | Post dividend |
| Malaysia | Late dividend | Late dividend |
| New Zealand | Late dividend | Late dividend |
| Philippines | Early dividend | Early dividend |
| Singapore | Late dividend | Post dividend |
| Thailand | Post dividend | Post dividend |
| Vietnam | Late dividend | Late dividend |

Source: IMF staff estimates based on Amaglobeli and Shi 2016 and United Nations 2015 (medium-fertility variant).

Note: Post dividend is defined as a total fertility rate 30 years earlier below 2.1 and a shrinking working-age population share over the subsequent 15 years or a shrinking absolute working-age population. Late dividend is defined as a total fertility rate 30 years earlier above 2.1 and a shrinking working-age population share over the subsequent 15 years. Early dividend is defined as an increasing working-age population share over the subsequent 15 years.

in absolute numbers; and (3) early-dividend economies, where the share of the working-age population will rise both as a share of the total population and in absolute terms over the next 15 years. The major Asian economies classified by these demographic groups in 2015 and 2030 are as follows (Table 2.1):

- **Post dividend:** This group includes China, Hong Kong SAR, Japan, Korea, and Thailand. These economies are projected to age rapidly and reach some of the highest old-age dependency ratios globally by 2050.[4] Japan is the most aged country globally, with an old-age dependency ratio of 43 percent at the end of 2015, which will rise to 71 percent by the end of 2050. Singapore is projected to transition to post-dividend status by 2030 (Table 2.2).
- **Late dividend:** This group includes Malaysia and Vietnam—two moderately aging emerging markets—as well as Australia and New Zealand, advanced economies that experienced a demographic transition earlier than other countries in the region, but maintain higher fertility rates than most East Asian economies and receive substantial immigration. Immigration has also kept Singapore in this category, despite one of the lowest fertility rates in the region.
- **Early dividend**: This group includes India, Indonesia, and the Philippines. These countries have some of the youngest populations in the region and will see their working-age populations increase substantially in coming decades. Fertility rates are projected to remain above the replacement rate of 2.1 children per woman for India and Indonesia until 2030 and beyond that for the Philippines. Indonesia is projected to transition to late-dividend status by 2030.

An important factor for the demographic evolution of some Asian economies is migration. As migrants tend to be of working age, migrant flows can slow the demographic transition in recipient countries. In Asia, immigration has

[4]China began relaxing its one-child policy in 2013 and, starting in 2016, allowed all couples to have two children. Demographers expect a positive but limited impact of the policy change on fertility (Basten and Jiang 2015). The 2015 UN population projections see the fertility rate gradually rising from 1.5 children per woman in 2010 to 1.7 by 2030 (United Nations 2015).

**Table 2.2. Asia: Old-Age Dependency Ratios**
*(Percent)*

| Country | 2000 | 2005 | 2010 | 2015 | 2020 | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Japan | 25.2 | 29.9 | 36.0 | 43.3 | 48.3 | 50.6 | 53.1 | 57.0 | 63.8 | 68.1 | 70.9 |
| Hong Kong SAR | 15.3 | 16.5 | 17.2 | 20.6 | 26.5 | 35.1 | 43.7 | 50.1 | 55.6 | 60.4 | 64.6 |
| Korea | 10.2 | 12.7 | 15.0 | 18.0 | 22.2 | 29.4 | 37.6 | 46.1 | 54.4 | 60.7 | 65.8 |
| Singapore | 10.3 | 11.3 | 12.2 | 16.1 | 21.4 | 28.6 | 36.5 | 43.7 | 51.1 | 57.2 | 61.6 |
| Thailand | 9.5 | 11.0 | 12.4 | 14.6 | 18.4 | 23.4 | 29.2 | 35.8 | 42.3 | 48.2 | 52.5 |
| New Zealand | 18.0 | 18.1 | 19.6 | 22.9 | 26.3 | 30.2 | 34.9 | 38.0 | 40.6 | 40.5 | 40.7 |
| China | 9.7 | 10.4 | 11.1 | 13.1 | 17.1 | 20.4 | 25.3 | 32.7 | 39.6 | 43.0 | 46.7 |
| Australia | 18.5 | 19.2 | 20.0 | 22.7 | 25.3 | 28.3 | 31.3 | 32.8 | 34.8 | 35.3 | 37.3 |
| Vietnam | 10.4 | 9.9 | 9.4 | 9.6 | 11.7 | 14.8 | 18.3 | 21.8 | 25.6 | 29.5 | 34.1 |
| Malaysia | 6.1 | 6.7 | 7.2 | 8.4 | 10.0 | 12.2 | 14.5 | 16.7 | 18.7 | 21.0 | 25.3 |
| Indonesia | 7.3 | 7.4 | 7.5 | 7.7 | 8.6 | 10.4 | 12.4 | 14.7 | 17.0 | 19.2 | 21.3 |
| India | 7.2 | 7.7 | 8.0 | 8.6 | 9.8 | 11.1 | 12.5 | 14.0 | 15.8 | 17.8 | 20.5 |
| Philippines | 5.5 | 5.8 | 6.7 | 7.2 | 8.0 | 9.1 | 10.3 | 11.5 | 12.5 | 13.5 | 14.5 |

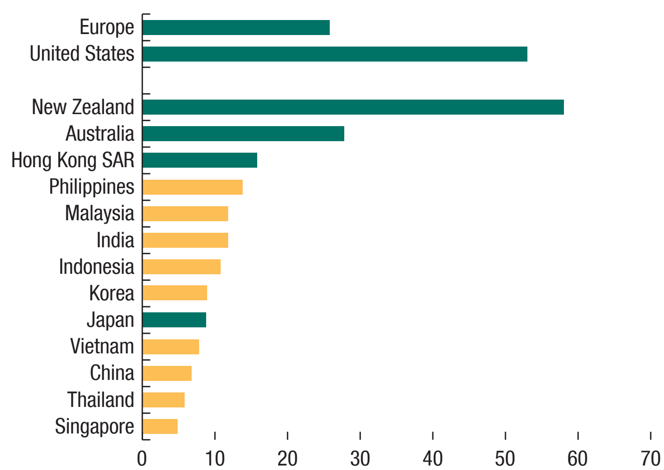
Source: IMF staff calculations and projections based on United Nations 2015 (medium-fertility scenario).
Note: The old-age dependency ratio indicates the size of the population 65 years of age and older as a share of the working-age population (15–64 years old).

been sizable in Australia, New Zealand, Hong Kong SAR, and Singapore. In these economies, continued immigration is projected to substantially slow the decline of working-age populations. The flipside of this is emigration of working-age people. This is of particular relevance for the Philippines, but even here the overall impact on the working-age population is small relative to the population size. For China, Japan, Korea and the remaining member countries of the Association of Southeast Asian Nations, net migration is relatively small.

While Asia is not the most aged region—Europe holds that distinction—the speed of aging in Asia is remarkable. Figure 2.2 shows the number of years it takes for the old-age dependency ratio to increase from 15 to 20 percent. The figure shows that this transition took 26 years in Europe and more than 50 years in the United States. In Asia, however, only Australia and New Zealand aged at similar speeds. For others, such as China, Japan, Korea, Thailand, Singapore, and Vietnam, the same transition has taken (or will take) less than 10 years.

The rapid speed of aging has two implications. First, countries in Asia will have less time to adapt policies to a more aged society than many advanced economies had. Second, some countries in Asia are getting old before becoming rich, or, to put it differently, they are likely to face the challenges of high fiscal costs of aging and

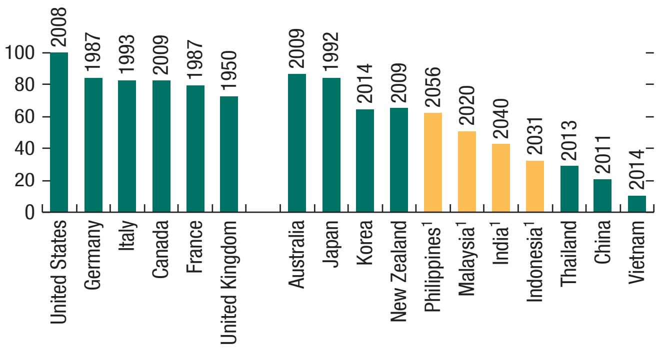
**Figure 2.2. Number of Years for the Old-Age Dependency Ratio to Increase from 15 Percent to 20 Percent**




Source: IMF staff calculations based on United Nations 2015 (medium-fertility scenario).
Note: The old-age dependency ratio indicates the population 65 years and older as a share of the working-age population (15–64 years). Countries in green reflect historical data, while countries in yellow reflect projections.

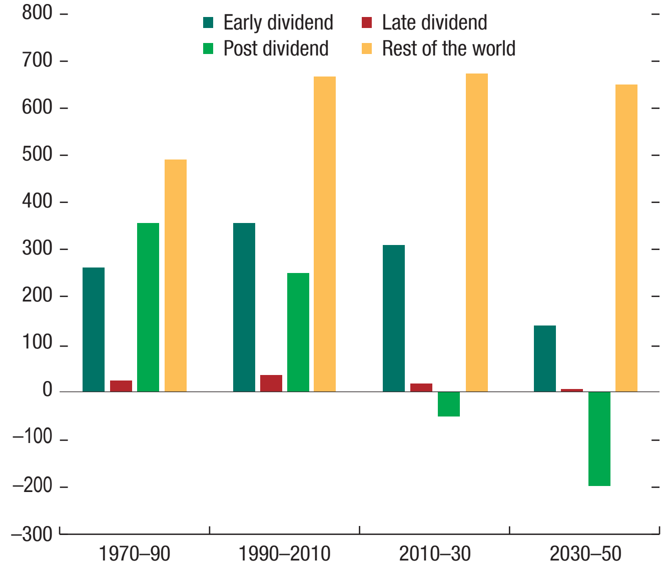
demographic headwinds to growth at relatively low per capita income levels. Figure 2.3 shows per capita income at purchasing power parity relative to the United States at the historical or projected peak of the share of the working-age population in each country. Except for Japan and Australia, per capita income in major Asian countries stands at significantly lower levels than those reached by mature advanced economies at the same stage of

**Figure 2.3. Per Capita Income Level at the Peak of Working-Age Population Share**
*(Purchasing power parity based; in percent of U.S. per capita income at each country's peak year)*




Sources: IMF World Economic Outlook (WEO) database; and IMF staff calculations based on United Nations World Population Prospects: 2015 Revision (medium-fertility scenario).
Note: For the countries shown above, the working-age population (15–64 years) share of the total population has peaked, or is projected to reach the peak, in the following years: United States (2008), Germany (1987), Italy (1993), Canada (2009), France (1987), United Kingdom (1950 or earlier), Australia (2009), Japan (1992), Korea (2014), New Zealand (2009), the Philippines (2056), Malaysia (2020), India (2040), Indonesia (2031), Thailand (2013), China (2011), Vietnam (2014).
[1]Based on IMF staff projection. For Malaysia, the income level relative to the United States is calculated from the April 2017 WEO projection for 2020. For India, Indonesia, and the Philippines, the income levels are calculated by applying the projected purchasing power parity per capita income growth rate in 2022, starting from 2023 and up to the year in which the working-age population share is projected to peak, respectively.

**Figure 2.4. Asia and the Rest of the World: Change in Working-Age Population**
*(Millions)*




Source: IMF staff calculations and projections based on United Nations 2015 (medium-fertility scenario).
Note: The working-age population is defined as those aged 15 to 64. Early-dividend economies comprise India, Indonesia, and the Philippines. Late-dividend economies comprise Australia, Malaysia, New Zealand, Singapore, and Vietnam. Post-dividend economies comprise China, Hong Kong SAR, Japan, Korea, and Thailand.

the aging cycle. This trend underscores the need to sustain high growth rates in these economies.

Asia's demographic evolution has important global implications through the region's contribution to global growth, current account balances, and capital flows, as well as relative wage levels and competitiveness. Figure 2.4 presents absolute changes in the working-age population for different demographic country groups in Asia and for the rest of the world. Between 1970 and 2010, Asia contributed more to the growth of the global working-age population than the rest of the world combined. This, however, is changing. Over the coming decades, rapidly aging East Asian economies are projected to see their working-age populations drop substantially. The decline is largest in absolute terms for China (a decline of 170 million in the working-age population over the next 35 years), but there are also substantial absolute declines projected for Japan, Korea, and Thailand. In contrast, the April 2015 *Regional Economic Outlook: Sub-Saharan Africa* projected that Africa will account for most of the growth in the global working-age population.

## Growth Implications of Demographic Trends

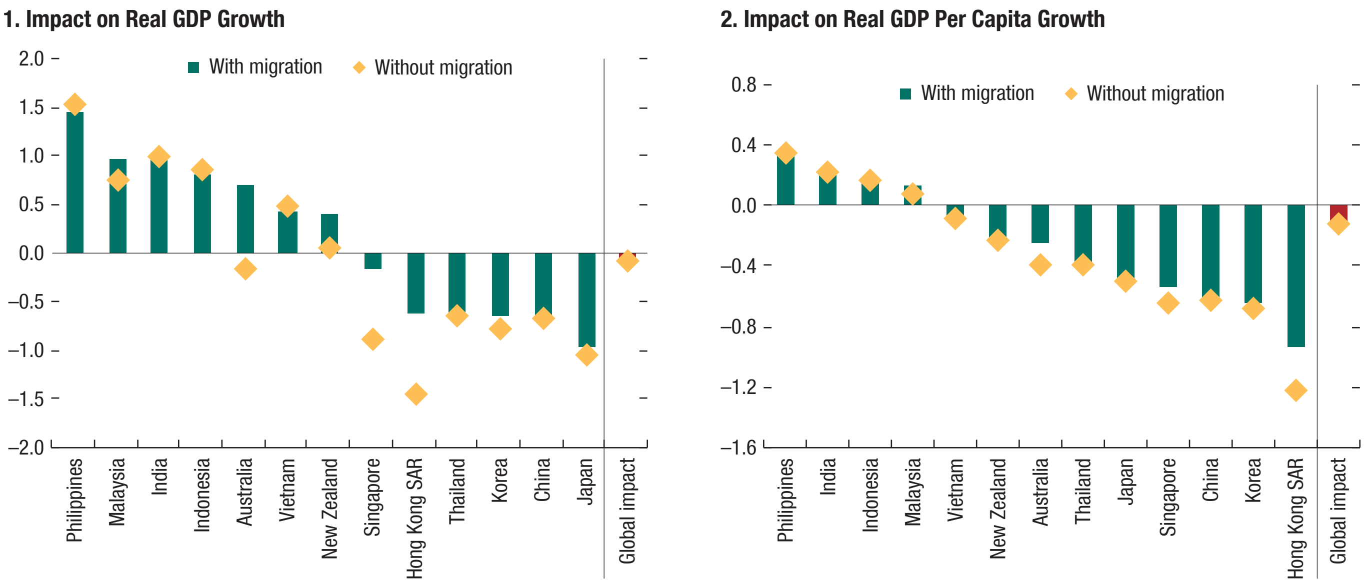
Asia has enjoyed a substantial demographic dividend in past decades, but rapid aging is now set to create a demographic "tax" on growth in several countries. To quantify this effect, this section employs a new template devised by Amaglobeli and Shi (2016) to assess the impact of demographic trends on growth.

### Impact of the Labor Force on Economic Growth

Demographic developments affect growth through various channels, including the size of the

**Figure 2.5. Asia: Baseline Growth Impact of Demographic Trends**

*(Percentage point impact on real GDP growth; average, 2020–50)*




Sources: IMF staff projections based on Amaglobeli and Shi 2016, United Nations 2015 (medium-fertility scenario), and Penn World Tables 9.0.
Note: The baseline estimates assume unchanged labor force participation by age-gender cohort, constant capital-to-labor ratio, and total factor productivity growth unchanged from historical average. Migration projections follow historical trends. Global impact indicates the purchasing-power-parity-weighted average as a percent of global GDP.

labor force, productivity, and capital formation. The analysis begins by establishing the direct impact on growth of demographic-induced changes in labor force size in a growth accounting framework. This baseline impact rests on several assumptions that are discussed later in this section:

- Unchanged total factor productivity (TFP) growth (based on the historical average)
- Unchanged age- and gender-specific labor force participation rates (and employment rates)
- Constant capital-to-effective-labor ratio[5]

With these assumptions, we estimate long-term output using a production function approach with capital and labor as inputs. Aggregate employment is decomposed into population by age-gender groups, and by group-specific labor force participation and employment rates. Population projections affect output in this framework through aggregate labor and capital. To establish the baseline impact of demographic change, we compare estimated output based on the UN's medium-fertility scenario (which includes migration) to a hypothetical status quo scenario that assumes constant population size and age structure. Separately, we also consider the UN zero-migration scenario to assess the impact of migration.

Figure 2.5, panel 1 shows the average annual growth impact from 2020 to 2050 relative to the status quo. The figure shows that:

- Demographic trends will turn into strong headwinds for post-dividend countries. In Japan, the impact of aging could reduce the average annual growth rate by almost 1 percentage point. The growth impact for

[5]This means that investment adjusts over time to the labor force, where labor is expressed in efficiency units (that is, incorporating TFP). For example, if the capital stock is 300 percent of GDP and the effective labor force growth declines by 1 percentage point, the investment ratio would fall by 3 percentage points of GDP. Since some substitution between capital and labor is likely, this assumption creates an upper bound for the growth impact.

China, Hong Kong SAR, Korea, and Thailand could be between one-half and three-quarters of a percentage point.[6] For Singapore, which transitions from late- to post-dividend status by 2030, the estimated overall impact is close to zero.

- Early- and late-dividend countries could still enjoy a substantial demographic dividend ranging from close to 1½ percent per year for the Philippines to ½ percent for New Zealand. It is important to note, however, that reaping the demographic dividend is not automatic, but depends instead on good policies to raise productivity and create a sufficient number of quality jobs for the growing working-age population, as discussed in Bloom, Canning, and Fink (2010).[7]
- Inward migration can prolong the demographic dividend or soften the impact of rapid aging. In the cases of Australia, Hong Kong SAR, New Zealand, and Singapore, the impact of continued immigration on the workforce could add between ½ and 1 percentage point to annual average growth.[8] The impact of net emigration from Indonesia, the Philippines, and Vietnam is small due to the small relative size of emigration as a share of population in these countries.
- Migration can reduce but cannot reverse the negative impact of aging on growth. For example, Australia would need to receive immigration equal to approximately 23 percent of the actual workforce to maintain the same dependency ratio by 2030. The same immigration figure for Singapore would be 51 percent.

Figure 2.5, panel 2 shows the growth impact on a per capita basis. The country ordering changes slightly on a per capita basis. Notably, the drag from demographics is smaller for Japan, but larger for Hong Kong SAR and Singapore, because the positive impact of immigration is partially eliminated in the per capita perspective.

We next relax several assumptions in this stylized exercise—in particular the assumptions of unchanged TFP growth and labor force participation rates—and then discuss why we keep the capital-to-effective-labor ratio assumption.

## Aging and Total Factor Productivity—An Additional Drag on Growth?

The first assumption in the baseline estimates is unchanged TFP growth. Studies, however, show that aging has implications for productivity growth. For example, different age groups differ in their productivity. This could be due to factors such as accumulation of experience over time, depreciation of knowledge, or age-related trends in physical and mental capabilities. Several studies find evidence of a decline in worker productivity and innovation starting between ages 50 and 60 (Aiyar, Ebeke, and Shao 2016; Börsch-Supan and Weiss 2016; and Feyrer 2007). In contrast, Acemoglu and Restrepo (2017) find no robust negative impact of aging on productivity.[9] Figure 2.6 shows that in most Asian countries the share of older workers (ages 55 to 65) in the

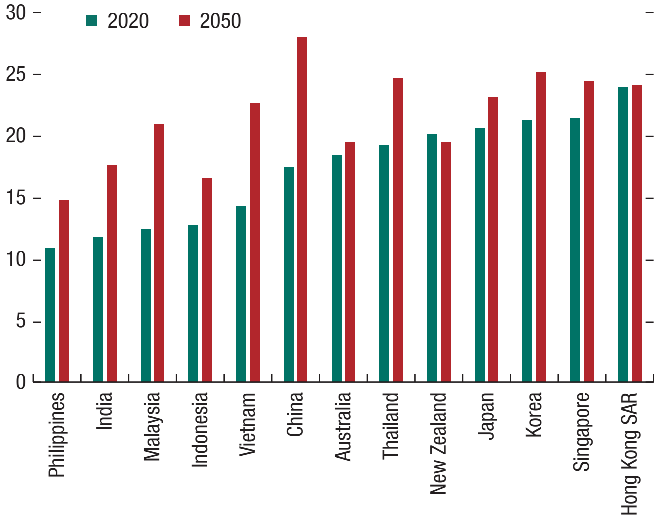
[6]The drag on growth is broadly stable for Japan over the next three decades, near 1.0 percentage point in each decade. In contrast, the drag for China rises over time, from 0.4 in the first decade to about 1.1 percentage points in the last decade.

[7]Long-term demographic projections are surrounded by uncertainties. A sensitivity analysis shows that compared to the UN's medium-fertility scenario, the average annual growth rate is about 0.2 percentage point higher in the UN's high-fertility scenario and about 0.2 percentage point lower in the low-fertility scenario.

[8]This effect is driven only by an enlargement of the workforce. In addition, Jaumotte, Koloskova, and Saxena (2016) estimate that a 1 percentage point increase in the share of migrants in the working-age population can raise GDP per capita over the long term by up to 2 percent by increasing labor productivity and, to a lesser extent, boosting investment. This second-round effect is not shown in Figure 2.5. The long-term UN assumptions on net migration rates for these countries range from 2.5 percent in New Zealand to 6 percent in Australia.

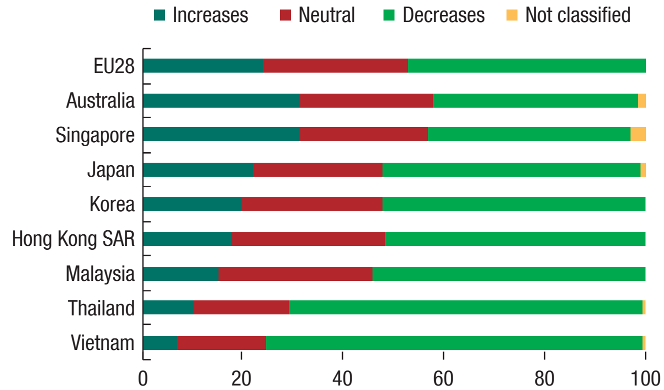
[9]Acemoglu and Restrepo (2017) run cross-country regressions linking aging to GDP per capita growth and conclude that there is no robust negative impact of aging. They argue that this might reflect the more rapid adoption of automation technologies in countries that are aging faster. The empirical approach in Adler and others (forthcoming) differs in that it (1) focuses on TFP rather than GDP per capita; (2) uses a tighter definition of aging based on the employed workforce's age, as opposed to the population's age; and (3) properly instruments for the employed workforce's age with past demographic characteristics of the population.

**Figure 2.6. Asia: Share of Older Workers in Working-Age Population**
*(Population aged 55–64 in percent of working-age population)*




Source: IMF staff estimates based on United Nations 2015 (medium-fertility scenario) and Penn World Tables 9.0.
Note: The working-age population is defined as those aged 15 to 64.

**Figure 2.7. Share of Workforce Whose Productivity Rises or Falls with Aging**
*(Percent of total workforce, latest available)*




Sources: International Labour Organization; Veen 2008; and IMF staff calculations.
Note: Category productivity "increases" with age comprises managers and professionals; category "neutral" comprises clerical support workers and services and sales workers; category "decreases" comprises technicians, skilled agricultural workers, forestry and fishery workers, craft and related trades workers, plant and machine operators and assemblers, elementary occupations, and armed forces occupations.

workforce is projected to increase substantially by 2050, with the largest increases in China, Malaysia, and Vietnam.

The impact of aging may also differ across professions. Veen (2008) argues that productivity of workers in physically demanding professions (factory workers, construction) declines at older ages, while productivity may increase with age in other professions such as lawyers, managers, and doctors. Figure 2.7 applies Veen's taxonomy to selected Asian economies. Countries with lower per capita income levels such as Thailand and Vietnam tend to have a larger share of their workforce in professions where productivity tends to decline with age. This underscores the importance of structural transformation to prepare for an aging workforce.

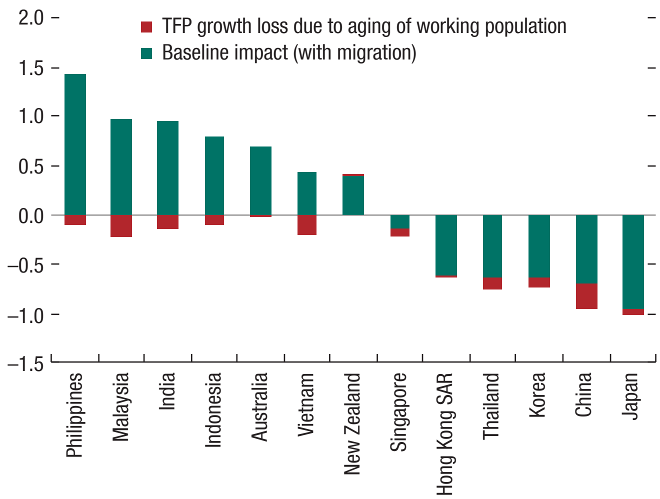
We estimate the effect of workforce aging (measured by the share of workers 55–65 years old in the total workforce) on productivity following the approach in Aiyar, Ebeke, and Shao (2016) and Adler and others (forthcoming).[10]

For a sample of Asian and European countries, we find that an increase in the share of older workers is associated with a significant reduction in labor productivity growth. We decompose the slowdown in labor productivity into factor accumulation and TFP, and find that most of the slowdown is through weaker TFP growth—that is, workforce aging is associated with lower annual TFP growth by 0.1 to 0.3 of a percentage point on average for Asia (see Annex 2.1). The results are quantitatively and qualitatively in line with the findings in Aiyar, Ebeke, and Shao (2016) for Europe and Adler and others (forthcoming) for the global sample.

Figure 2.8 shows the estimated impact of projected workforce aging on growth for different Asian economies. On average, an older workforce is estimated to reduce growth by 0.2 percent per year, with the biggest impact for China (0.3 percent per year). The impact is higher for countries that are projected to experience

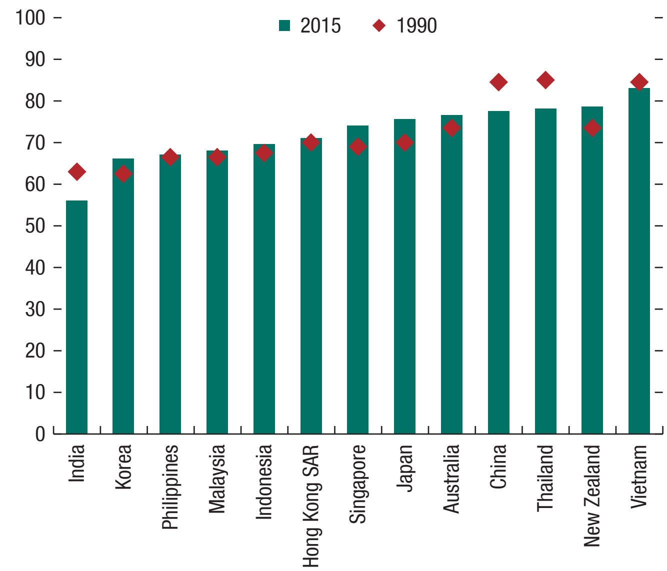
[10]These two studies broadly use the same approach, regressing either the TFP level or TFP growth on demographic variables, and testing whether workforce aging is associated with a permanent loss in productivity or a slowdown in productivity growth due to less innovation.

**Figure 2.8. Baseline Growth Impact of Demographic Trends and Impact of Aging on Total Factor Productivity**
*(Percentage point impact on real GDP growth; average, 2020–50)*




Source: IMF staff estimates based on United Nations 2015 (medium-fertility scenario) and Penn World Tables 9.0.
Note: Estimated impact of workforce aging on total factor productivity (TFP) growth follows Aiyar and others 2016 based on a sample of Asian and European countries.

**Figure 2.9. Labor Force Participation Rates by Ages 15–64 in 1990 and 2015**
*(Percent of population between ages 15 and 64 years)*




Source: IMF staff calculations based on International Labour Organization figures.

workforce aging faster (the countries were shown in Figure 2.6). This may be a substantial drag on future TFP growth for some countries, but is likely to be of second-order magnitude compared to the baseline growth impact of changes in the size of the labor force.

## Higher Labor Force Participation Rates to the Rescue?

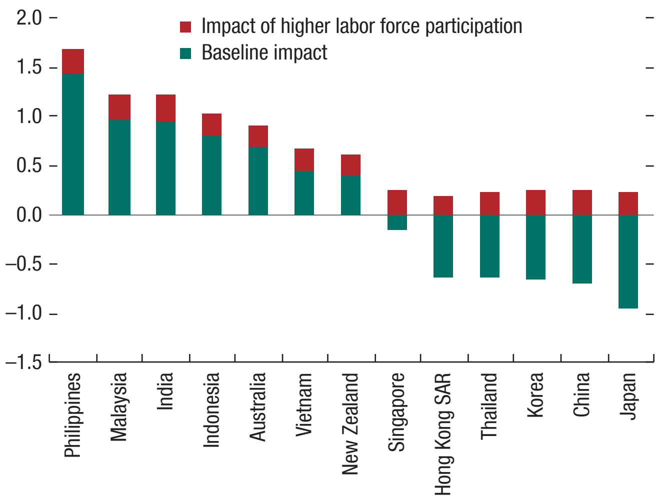
The second assumption in the baseline estimates are constant age-gender-specific labor force participation rates (LFPRs). However, LFPRs change over time and can be affected by policies. For example, increases in life expectancy could encourage the elderly to stay in the workforce. Indeed, in most Organisation for Economic Co-operation and Development (OECD) countries, the effective retirement age has increased, even though these increases have been modest compared to the larger increases in life expectancy (Bloom, Canning, and Fink 2010). Alternatively, the decline in fertility rates could encourage women to participate more in the labor force (Bloom and others 2007). In most Asian economies, there is indeed scope for greater female labor force participation, although unleashing the full potential of female employment requires a comprehensive set of policies (Steinberg and Nakane 2012; Elborgh-Woytek and others 2013; Kinoshita and Guo 2015). In contrast, LFPRs tend to decline for younger workers as countries develop and average years of schooling increase.

Figure 2.9 shows the changes in LFPRs for working-age populations in Asian economies between 1990 and 2015. The first thing to note is that, overall, LFPRs have remained remarkably stable over this period, despite notable shifts for age-gender subgroups.[11] The second thing to note is that in Japan, the most aged country globally, LFPRs have increased the most in the region—by close to 6 percentage points since 1990 (Box 2.1).

[11]In particular, (1) female LFPRs have increased in the region's advanced economies, but declined in China, India, Thailand, and Vietnam, while male LFPRs have declined in most countries; (2) LFPRs for young workers ages 15–24 have dropped in all countries by up to a third, reflecting longer schooling; and (3) LFPRs for older workers ages 55–64 have increased in most countries, most notably Australia, New Zealand, and Singapore.

**Figure 2.10. Baseline Growth Impact of Demographic Trends and Higher Labor Force Participation**

*(Percentage point impact on real GDP growth; average, 2020–50)*




Source: IMF staff estimates based on Amaglobeli and Shi 2016, United Nations 2015 (medium-fertility scenario), and Penn World Tables 9.0.
Note: The rising labor force participation rates scenario is based on the experience of Japan from 1990 to 2015 (Box 2.1).

What if other Asian economies were to achieve a rise in LFPRs similar to that of Japan? Figure 2.10 shows the impact of such a scenario on growth, where we allowed for a gradual increase in LFPR for all age and gender groups by 6 percentage points. Such a scenario could certainly boost growth—the impact on annual GDP growth for this scenario is 0.2 to 0.3 of a percentage point—and offset the lower TFP growth due to workforce aging, as discussed previously. However, such changes in the LFPR are unlikely to counter the baseline growth effects induced by changes in the overall labor force.[12]

## Aging and Investment

The third assumption in our baseline impact estimates is a constant capital-to-effective-labor ratio. We examined this question in the analytical framework introduced to analyze the impact of workforce aging on TFP. In that analysis, we find that workforce aging is associated with higher capital per worker (accounting for TFP), but economically the effect is small. Similarly, we do not find a statistically significant relationship between the old-age dependency ratio and capital per worker. Taken together, this suggests that a constant capital-to-labor-ratio assumption is a reasonable approximation, especially for thinking about the next three decades, when countries would presumably be on a balanced growth path.

Overall, demographic trends could reduce growth by ½ to 1 percentage point per year in absolute and per capita terms over the next three decades in post-dividend countries. Over the long term, these sustained reductions in growth rates have important welfare implications: a 0.5 percentage point reduction in growth per year would reduce the level of GDP by 2050 by about 15 percent.

## External Balance Implications of Demographic Trends

The impact of demographics on savings, investment, and hence the current account is examined using the EBA model (Phillips and others 2013; IMF 2016). The impact is captured using three variables (see Annex 2.1 for details): population growth, old-age dependency ratio,[13] and aging speed (defined as the expected change in old-age dependency in 20 years).[14] In particular:

[12]Note that the impact on growth for small changes in LFPRs is close to linear. A more ambitious scenario in which the employment gender gap is eliminated could add ¼ of a percentage point to annual GDP growth for Japan and up to 1 percentage point for India by 2050 (Cuberes and Teignier 2016; Elborgh-Woytek and others, 2013; Khera 2016). Moreover, Gonzales and others (2015) show that reducing a broader measure of gender inequality in education, political empowerment, LFPR, and health could lower income inequality and boost growth (that is, a 10 percentage point reduction in the gender inequality index is associated with almost 1 percentage point higher per capita GDP growth).

[13]Following the EBA model, the working-age population is defined as persons ages 30 to 64, which in effect captures the prime-age population. Since 15 year-olds are not routinely in the employed population, the prime-age population is considered a better choice for examining savings-investment relationships. Accordingly, the old-age dependency ratio indicates those ages 65 and over as a share of the prime-age population.

[14]In the EBA model, population growth is a proxy for the fertility rate or youth dependency ratio. Aging speed is a measure of the "probability of survival" or longevity, reflecting the future prospects

**Table 2.3. Expected Impact of Demographic Variables on Current Account**

| | Savings | Investment | Current Account |
|---|---|---|---|
| Population Growth | ↓ | ↑ | ↓ |
| Old-Age Dependency | ↓ | ↓ | Ambiguous |
| Aging Speed | ↑ | ↓ | ↑ |

Source: Authors.

- **Savings**. In principle, countries with higher shares of dependent populations generally have lower savings.[15] Therefore, both higher population growth (a proxy for higher youth dependency) and higher old-age dependency are linked with lower savings (Table 2.3). In contrast, higher aging speed implies a higher probability of survival and therefore a greater need for life-cycle savings.[16]
- **Investment**. As population growth increases, the capital-to-labor ratio falls (therefore raising the return on capital and boosting investment).[17] Rising old-age dependency works in the opposite direction, as it leads to a higher capital-to-labor ratio. Aging speed, to the extent it reflects expectations of a larger future elderly population and lower future aggregate demand, would also result in lower investment.
- **Current account balance**. In summary, population growth, aging speed, and rising old-age dependency are expected to have a negative, positive, and ambiguous impact on the current account, respectively.

Empirical results based on the EBA model support our priors on the effect of population growth and aging speed. Furthermore, higher old-age dependency is found to be positively associated with the current account balance when aging speed is higher than the world average.

What does the EBA model suggest for regional current account norms in the coming decade?[18] By 2020, Australia, Japan, and New Zealand will have higher old-age dependency ratios compared to the (GDP-weighted) world average. By 2030, Hong Kong SAR, Korea, and Singapore will also have higher old-age dependency ratios than the world average.[19] Moreover, several countries in the region—most notably Hong Kong SAR, Japan, Korea, and Singapore (advanced economies) and China, Thailand, and Vietnam (emerging markets)—will have very high speeds of aging until 2030 (see Annex 2.1). In contrast, some advanced economies (Australia and New Zealand), will have lower speeds of aging than the world average.

Over 2020–30, the EBA model suggests that all else being equal, demographic trends are likely to exert upward pressure on current account balances in surplus countries, such as Japan, Korea and Thailand, given the rise in their aging speeds from 2020 to 2030 (Figure 2.11). Among deficit countries, demographic trends are likely to exert downward pressure, particular in New Zealand, given its falling aging speed. Overall, demographics are projected to materially increase current account norms only for a select few countries in Asia, and the total impact of

of population aging, while old-age dependency captures the outcome of population aging so far (see Annex 2.1).

[15]Grigoli, Herman, and Schmidt-Hebbel (2014) provide a comprehensive survey of saving determinants and find that both youth and old-age dependency lower savings in theoretical as well as empirical literature.

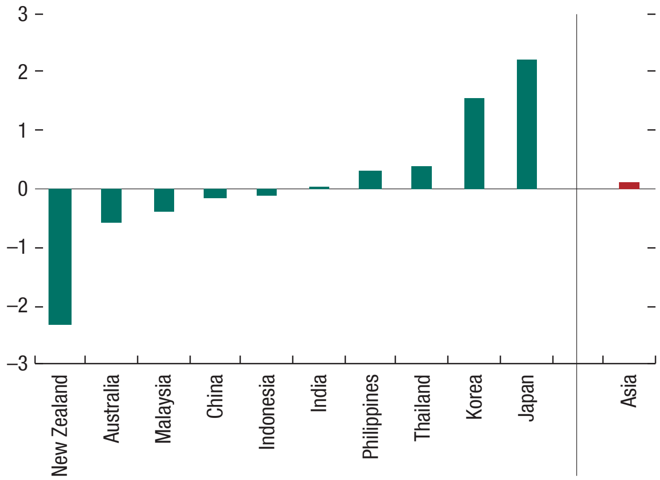
[16]In particular, as people expect to live longer, they are induced to save more, counterbalancing the effects of higher old-age dependency (Li, Zhang, and Zhang 2007). Therefore, in the literature the impact of aging on saving behavior is subject to model uncertainty, depending on whether this forward-looking element is accounted for.

[17]The impact of population growth (or youth dependency) on investment is less certain than on savings. While some studies find a positive effect (Higgins 1998), others find a negative effect (Williamson 2001; Bosworth and Chodorow-Reich 2007).

[18]The rest of this section focuses on old-age dependency and aging speed as the main drivers of the current account norm because changes in population growth from 2020–30 are expected to be relatively small—in particular, the contribution of population growth to changes in current account norms is less than 0.1 percent of GDP for our sample period. See Annex 2.1 for details on the EBA methodology and an estimation of current account norms.

[19]Demographic variables are expressed relative to the (GDP-weighted) world average, reflecting the fact that countries need to be at different stages of the demographic transition in order for it to have an impact on their external positions.

**Figure 2.11. Demographic Impact on Current Account Norms**
*(Percent of GDP, change from 2020 to 2030)*



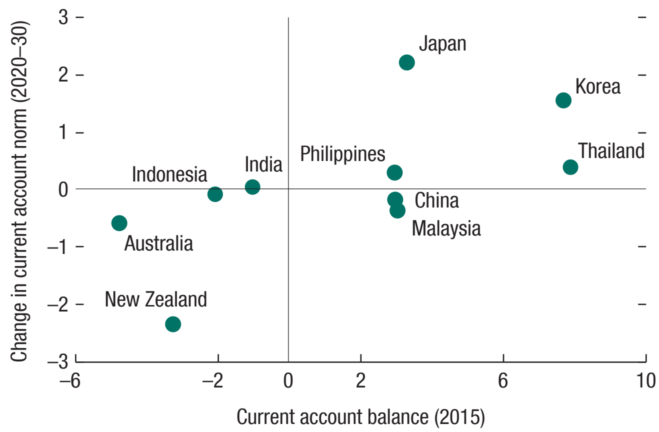

Sources: IMF *World Economic Outlook*; United Nations 2015 (medium-fertility scenario); and IMF staff estimates.
Note: Current account norms (based on demographic variables only) are adjusted for multilateral consistency. Asia impact indicates the sum of projected changes in Asia's current accounts as a percent of world GDP. Hong Kong SAR, Singapore, and Vietnam are not shown as they are not included in the sample for the External Balance Approach model.

demographics on global imbalances is limited (Figure 2.11).

What will be the effect on capital flows? All else being equal, demographic factors are likely to strengthen the current dynamics of capital flows. In particular, Figure 2.12 shows that, over 2020–30, changes in current account norms due to demographic trends are likely to be positively correlated with current account balances in 2015. That is, countries with current account surpluses are expected to remain capital exporters, while those in deficit are expected to remain capital importers.

The results above are based on a partial equilibrium analysis, which takes the values of other macroeconomic variables in the EBA model as fixed—for instance, the future expected growth rate, the level of relative productivity, relative output gap, and relative fiscal balance. The broader impact of demographics may be smaller or larger

**Figure 2.12. Changes in Current Account Norms Induced by Demographics and Current Account Balances in 2015**
*(Percent of GDP)*




Sources: IMF *World Economic Outlook*; United Nations 2015 (medium-fertility scenario); and IMF staff estimates.
Note: Current account norms (based on demographic variables only) are adjusted for multilateral consistency.

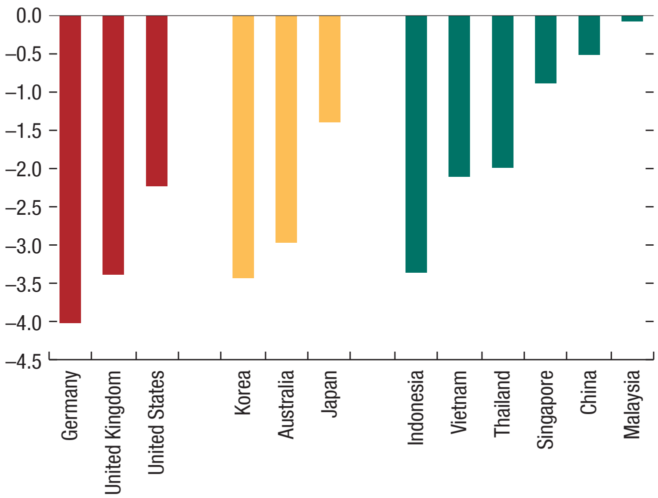
than the estimated partial effect depending on how aging interacts with these variables.[20]

## Financial Market Implications of Demographic Trends

The changes in savings and investment associated with aging can also have implications for domestic financial markets. To investigate these effects, a panel regression was conducted to examine the potential impact of demographic trends on domestic interest rates, equity returns, and real estate prices in the region (see Annex 2.1). Overall, the results suggest that rising old-age dependency in post-dividend countries and falling youth dependency in early-dividend countries are both likely to put downward pressure on domestic real interest rates. The impact of these factors diminishes for countries that are financially more open.

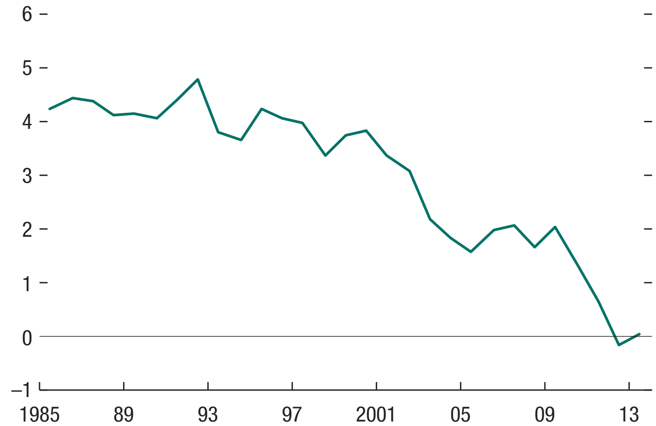
[20]For example, aging may affect fiscal balance through higher pension and health care spending. Since public health spending is included as a control variable in EBA, the estimates (Figure 2.17) account for this channel based on health spending projections (Amaglobeli and Shi 2016). However, the estimates do not account for the role of generosity of pension systems, which could be an important factor behind the private savings behavior.

**Figure 2.13. Selected Asia: Change in 10-Year Government Bond Yield**
*(Percentage points; end-2016 compared with 2000–07 average)*



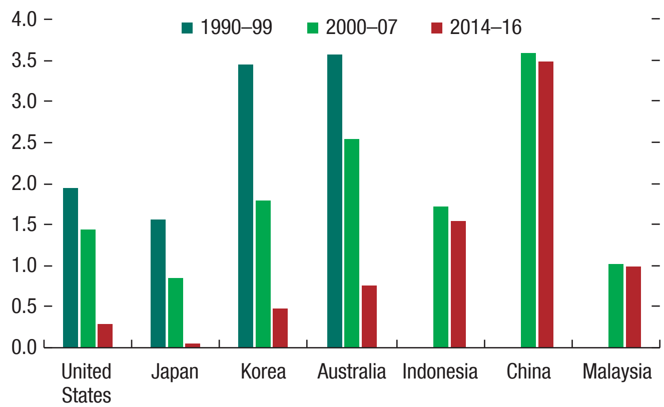

Sources: Bloomberg L.P.; CEIC Asia database; Haver Analytics; and IMF staff calculations.

**Figure 2.14. World Real Interest Rates**
*(Percent)*




Source: King and Low 2014.

**Figure 2.15. Selected Asia: Real Neutral Interest Rates**
*(Percentage points)*




Sources: Haver Analytics; IMF, *International Financial Statistics*; and IMF staff estimates.

## Interest Rates

The decline in long-term interest rates is a global phenomenon, with Asia being no exception. Long-term bond yields have declined significantly in Europe and the United States. A similar trend is observed in Asia, particularly in Australia and Korea, where the decline has been nearly as large (Figure 2.13). Besides reflecting better-anchored inflation expectations, this has also reflected a significant decline in world real interest rates, which have drifted down from around 4 percent in the late 1990s to about zero recently (Figure 2.14).

The decline in real interest rates has in turn reflected the decline in the natural rate of interest.[21] Studies have shown that the estimated natural rates of interest in Europe, the United Kingdom, and the United States have declined dramatically since the start of the global financial crisis (Holston, Laubach, and Williams 2016; Lubik and Matthes 2015; Rachel and Smith 2015). In Asia, natural rates have also fallen in advanced economies (Australia, Japan, and Korea), while remaining broadly stable and relatively high in emerging market economies that have yet to come under aging pressures. In China, natural rates have fallen, but remain high relative to advanced Asian economies (Figure 2.15).

Demographics, among other factors, have been hailed as important drivers of the secular decline in interest rates.[22] In a closed economy,

[21]The natural rate is the interest rate that is consistent with full employment and inflation at the central bank's target.

[22]Other drivers of the secular decline in natural interest rates can be a slowdown in trend productivity growth, shifts in saving and investment preferences (that is, rising inequality), precautionary savings in emerging markets, a fall in the relative price of capital goods, and a preference away from public investment (Rachel and Smith 2015). While this section focuses on real interest rates, low

**Table 2.4. Expected Impact of Demographic Variables on Interest Rate**

| | Savings | Investment | Interest Rates |
|---|---|---|---|
| Youth Dependency | ↓ | ↑ | ↑ |
| Old-Age Dependency | ↓ | ↓ | Ambiguous |
| Aging Speed | ↑ | ↓ | ↓ |

Source: Authors.

demographics can impact savings and thereby interest rates, primarily through youth dependency, old-age dependency, and aging speed (Table 2.4):[23]

- **Youth dependency.** In principle, as the youth dependency ratio rises, the transition working-age cohort saves less, the capital-to-labor ratio falls, and interest rates rise. Youth dependency is expected to fall drastically in early-dividend countries, such as the Philippines and India (Figure 2.16, panel 1).
- **Old-age dependency.** As old-age dependency rises, savings fall. Moreover, as the labor force shrinks, the capital-to-labor ratio rises, and investment falls. Therefore, the impact of old-age dependency on interest rates is theoretically uncertain. Old-age dependency is expected to rise relatively quickly in Hong Kong SAR, Korea, and Singapore (Figure 2.16, panel 2).
- **Aging speed.** Higher aging speed implies a higher probability of survival, which, if not matched by later retirement, is likely to have a positive impact on life-cycle savings. Higher aging speed also lowers current investment, as mentioned earlier, thereby reducing interest rates. Aging speed is currently high and expected to fall in countries in late stages of the demographic transition (Figure 2.16, panel 3). Japan, where aging speed will continue to increase in the next decade, is an exception.

The empirical estimates support our priors for the effect of youth dependency and aging speed on interest rates. Furthermore, higher old-age dependency is found to reduce interest rates in our sample.

The effects of demographic factors are not wholly channeled domestically in open economies. As one moves to an economy with an open capital account, the savings-investment balance, and hence interest rates, are at least partly determined by global savings and investment. In the extreme case of perfect capital mobility, arbitrage in financial markets should equalize interest rates across borders, and demographic factors of each country should not have an impact on domestic interest rates (unless they are large enough to contribute to global demographic trends).

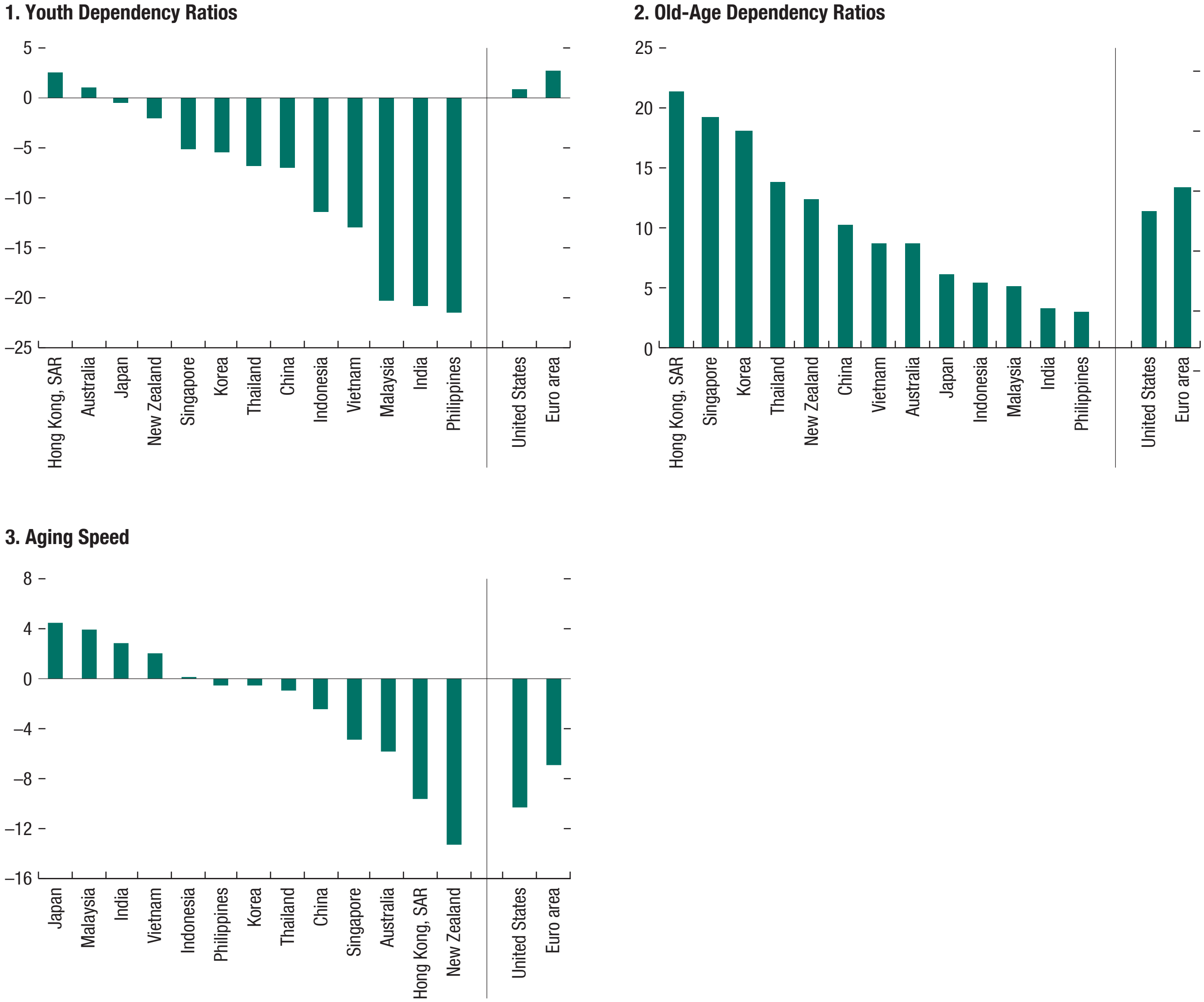
Indeed, we find that the impact of domestic demographic factors on interest rates tends to diminish as a country becomes more open.[24] In our analysis (see Annex. 2.1), the impact of demographic variables—youth dependency, old-age dependency, and aging speed—all become zero as an economy becomes perfectly open (based on the Chinn-Ito index). Youth dependency, old-age dependency, and aging speed are expressed as ratios. Therefore, a 1 percentage point increase in youth dependency increases the interest rate by 8.26 basis points when the economy is fully closed, while there is no impact in the case of a fully open economy (Table 2.5). Hence, in estimating the demographically induced changes in real interest rates over 2020–30, interest rates in Hong Kong SAR, Japan, New Zealand, and Singapore with full capital mobility

interest rates may also reflect low steady-state inflation due to similar demographic pressures that weaken growth and drive up savings (see Box 2.1 on Japan).

[23]The previous section on external balance was based on the EBA model, which uses population growth as a proxy for youth dependency. Since youth dependency is a more direct measure of population dynamics (and a complement to the old-age dependency ratio), we use that in this section.

[24]While we find that the impact of domestic demographic factors diminishes as a country becomes more open, we neither test nor find evidence for real interest rate parity (as reflected by non-zero country fixed effects).

**Figure 2.16. Selected Asia: Demographic Profile**
*(Percentage points, change between 2020 and 2030)*




Sources: IMF, *World Economic Outlook*; United Nations 2015 (medium-fertility scenario); and IMF staff estimates.
Note: Aging speed is the projected change in the old-age dependency ratio over the next 20 years. Youth dependency ratio indicates the size of the population 14 years of age and younger as a share of the prime working-age population (30–64 years old). Old-age dependency ratio indicates the size of the population 65 years of age and older as a share of the prime working-age population (30–64 years old).

are decoupled from their domestic demographic trends.

Among countries that are not perfectly open, the old-age dependency effect is important for mature economies, while the youth dependency effect dominates for economies that are relatively young. Increasing old-age dependency is expected to decrease interest rates, with the effect most prominent for post-dividend countries such as China, Korea, and Thailand. Declining youth dependency, especially in early-dividend countries such as India, Indonesia, and the Philippines, whose fertility rates are projected to decline, is expected to decrease interest rates.

A slower pace of aging can be expected to push up interest rates. Interest rates are expected to

**Table 2.5. Openness and Estimated Impact of Demographic Variables**

| Variable/Coefficient Value | Fully Closed | Fully Open |
|---|---|---|
| Youth Dependency | 8.26 *(1.95)* | 0 |
| Old-Age Dependency | −16.16 *(5.51)* | 0 |
| Aging Speed | −29.26 *(9.87)* | 0 |

Source: IMF staff calculations.
Note: Standard errors are in parentheses.

increase most markedly in China and Australia as the aging speeds in these countries fall. Given that these economies are already relatively aged, their aging speeds slow and result in a fall in savings and, consequently, an increase in interest rates. On the other hand, aging speed is projected to increase in currently young countries such as India and Malaysia, driving down their interest rates.

Overall, the results suggest that demographic trends could put downward pressure on interest rates by about 1 to 2 percentage points in the next decade, all else being equal (Figures 2.17 and 2.18).[25,26] The impact depends on three factors: the degree of openness, the state of aging, and the speed of aging. For countries that are fully open, demographic factors do not have a direct effect on domestic long-term interest rates. For post-dividend countries (Korea and Thailand), rising old-age dependency is expected to depress interest rates. For early-dividend countries (India and the Philippines), falling youth dependency is projected to reduce interest rates. Finally, as the speed of aging slows in some cases, the aging speed effect will attenuate the decline in interest rates.

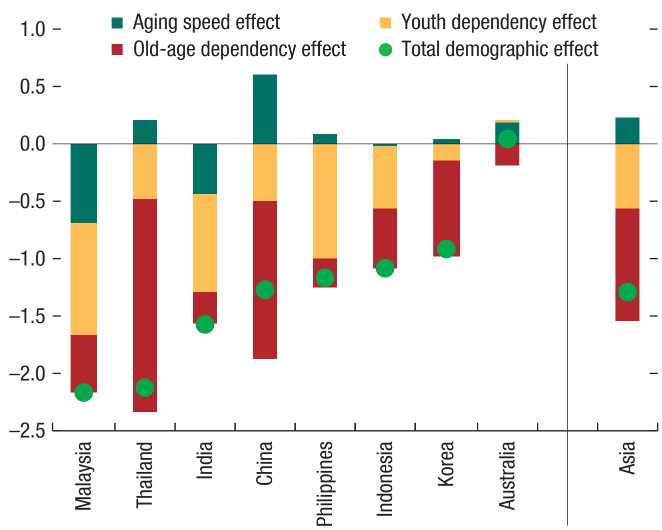
## Other Asset Valuations

What about the impact of demographic trends on other asset classes, in particular, stocks and real estate? A popular argument in the literature is the "asset market meltdown" hypothesis, which

[25]Given the low-frequency variation in demographic variables, annual real interest rates may introduce substantial noise to any relationship with demographic structure. To account for this, we have also considered three- and five-year rates for nonoverlapping periods, as explained in Annex 2.1. Such multi-period rates will tend to emphasize the low-frequency variation in real interest rates. The results are broadly similar to the baseline scenario.

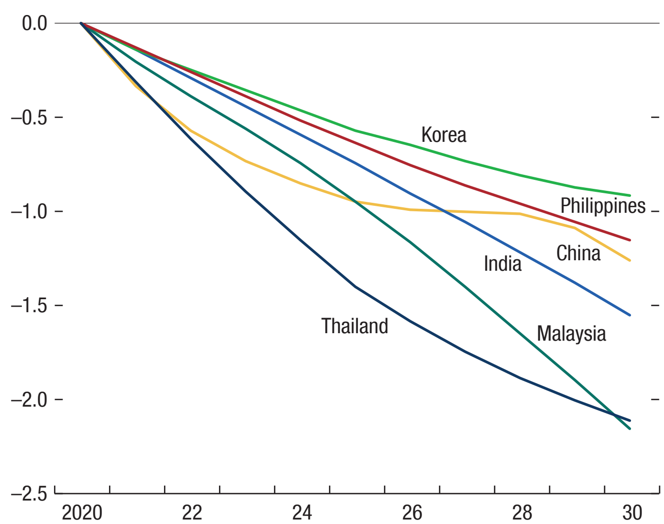
[26]Rachel and Smith (2015) find that demographic factors along with public investment and a global savings glut can explain about 2 percentage points (out of 4.5 percentage points) of the decline in global neutral rates between 1980 and 2015.

**Figure 2.17. Selected Asia: Impact of Demographics on 10-Year Real Interest Rates**
*(Percentage points, cumulative change between 2020 and 2030)*




Source: IMF staff estimates.
Note: The figure for Asia reflects the nominal GDP-weighted average.

**Figure 2.18. Selected Asia: Impact of Demographics on 10-Year Real Interest Rates**
*(Percentage points, cumulative change between 2020 and 2030)*




Source: IMF staff estimates.

**Table 2.6. Expected Impact of Demographic Variables on Asset Returns**

| | Interest Rate | Risk Appetite | Equity Premium | Stock Returns |
|---|---|---|---|---|
| Youth Dependency | ↑ | ↑ | ↓ | Ambiguous |
| Old-Age Dependency | ↓ | ↓ | ↑ | Ambiguous |
| Aging Speed | ↓ | ↑ | ↓ | ↓ |

Source: Authors.

postulates that as baby boomers retire and draw down their savings, the resulting sell-off pressure in asset markets sharply reduces valuations. Historical experience in the United States and Japan provides some indication of the correlation between demographics and postwar stock market trends. But, generally, recent empirical studies have found mixed evidence of the link between demographics and asset returns (see Annex 2.1). This is also our finding in this chapter.

In principle, demographic trends—through their impact on interest rates and risky premiums—can influence expected stock returns (Table 2.6).[27] In particular, as discussed in the previous section, a decline in youth dependency, or an increase in old-age dependency, are expected to lead to a fall in interest rates. At the same time, these trends would reduce the lifetime investment horizon, lower the preference for risky assets, and thereby raise the equity risk premium.[28] In sum, the expected impact of dependency ratios on stock returns is conceptually ambiguous.

Empirically, we find that lower youth (or higher old-age) dependency is associated with lower stock returns (that is, the interest rate channel dominates), but the results are not statistically strong. Moreover, as with interest rates, we find that the impact of domestic demographic factors is partially offset in more financially open countries.

In the case of real estate, the relationship with demographic variables is even more difficult to identify due to the asset's dual role as a durable good. Conceptually, a fall in interest rates, triggered by a fall in youth dependency (or a rise in old-age dependency), would raise house prices. At the same time, these trends are expected to reduce the demand for housing, as they are associated with declines in household formation.[29] Indeed, empirically, we find weak links between these variables and real estate prices. The degree of openness plays an insignificant role in the case of real estate, likely reflecting the local nature of housing markets.

## Policy Implications of Demographic Trends

For early-dividend countries (India, Indonesia, and the Philippines), the main policy challenge is to harness the demographic dividend where possible, as discussed in Bloom, Canning, and Sevilla (2003), and mitigate any adverse spillovers from aging in the rest of Asia.

For Asian countries in the late- or post-dividend stages, adapting to aging could be especially challenging owing to the rapid aging at relatively low per capita income levels. In light of this, policies aimed at protecting the vulnerable elderly and prolonging strong growth take on particular urgency in Asia. These challenges call for adapting macroeconomic policies early on before aging sets in. Specific structural reforms can also help, especially in the areas of labor markets, pension systems, and retirement systems. These policies could be supplemented by productivity-enhancing reforms (for example, research and development and education), as discussed in detail in Chapter 3.

[27]Expected stock returns are, by definition, equal to the sum of the risk-free rate and equity risk premium.

[28]If the correlation between labor income and stock returns is sufficiently low, a labor income stream would act as a substitute for risk-free bond holdings. This implies people should hold a declining share of stocks in their portfolio as they get older (Jagannathan and Kocherlakota 1996).

[29]Furthermore, an initial house price increase due to a positive demand shock may be masked in the data by the subsequent downward price adjustments, as the housing stock supply responds with lags (Lindh and Malmberg 2008; Poterba 1984). Moreover, higher demand for housing could manifest itself more prominently through the rental rate, which may not always move together with house prices (Hamilton 1991).

## Macroeconomic Policies

The experience of Japan shows that it is important to adapt macroeconomic policies early on before aging sets in. In terms of fiscal policy, this may include introducing a credible medium-term fiscal framework to secure debt sustainability, shifting the burden of taxes from labor to consumption, and revamping the social safety net.[30] In terms of monetary policy, it may involve studying how monetary transmission may change with aging. For example, if monetary transmission works more through asset prices and household wealth, rather than corporate borrowing costs, the interest rate sensitivity of output and inflation may decline (Miles 2002; Bean 2004). Moreover, to the extent that aging leads to declines in the natural interest rate, regular assessment of the neutral monetary stance by central banks would be needed to avoid a potential tightening bias. Prolonged low interest rates may also call for a strong macro-prudential framework to mitigate related financial stability risks.

## Structural Reforms: Labor Market

Labor market reforms aimed at tackling labor shortages and workforce aging can help offset some of the adverse growth effects of aging discussed in the chapter. In particular, reforms could be directed at:

- *Raising labor force participation*, especially for women and the elderly. Expanding the availability of child-care facilities, removing fiscal disincentives to dependents' labor participation, and promoting flexible employment can be especially effective at raising female and elderly labor participation (Elborgh-Woytek and others 2013; Kinoshita and Guo 2015; Olivetti and Petrongolo 2017). Japan's experience in this regard can be particularly instructive (Box 2.1). Furthermore, moving from a seniority-based to a performance-based wage system can incentivize firms to relax retirement age requirements, while reducing labor market duality (Dao and others 2014).
- *Encouraging foreign workers*, including through guest worker programs that target specific skills. This could address labor shortages and have a generally positive impact on receiving countries (Ganelli and Miake 2015; Jaumotte, Koloskova, and Saxena 2016). The cases of Australia, Hong Kong SAR, New Zealand, and Singapore show that immigration can prolong the demographic dividend or soften the negative impact of rapid aging.[31]
- *Promoting active labor market policies.* As discussed in the chapter, workforce aging can exert a further drag on productivity growth. This negative effect could be alleviated by improving affordable health care for mature workers, who are disproportionately affected by health risks, and facilitating human capital upgrading and retraining (Aiyar, Ebeke, and Shao 2016).

## Structural Reforms: Pension Systems

Given the rapid aging and related fiscal costs (Box 2.2) in Asia, as well as the region's relatively low pension coverage (World Bank 2016), strengthening pension systems takes a high priority. Policy measures could include:

- *Entitlement reform through automatic adjustment mechanisms that link changes in the retirement age (or benefits) to life expectancy.* This could help de-politicize pension reform and contain pension costs (Arbatli and others 2016). Although such rules have been introduced in many European countries, their use has been limited to date in Asia, except for Japan (Box 2.2).

[30]At the same time, with a credible medium-term fiscal framework, fiscal policy can be used more actively in the short run given its higher potency in a low-interest-rate environment, including to support aging-related structural reforms.

[31]Recent IMF research finds that a key to harnessing the long-term gains of foreign workers is active policies that facilitate the integration of immigrants into the labor market, including language training and job search assistance, better recognition of migrants' skills through the recognition of credentials, and lower barriers to entrepreneurship (IMF 2017).

Fiscal incentives to encourage voluntary savings (for example, tax deductions for long-term retirement savings) can also help relieve long-term fiscal burdens.

- *Raising pension coverage through minimum pension guarantees.* This could provide a safety net for the vulnerable, mitigate the impact of entitlement reforms, and reduce incentives for precautionary savings (Zaidi, Grech, and Fuchs 2006).
- *Reforming the management of public pension funds.* Asia is home to some of the largest public pension funds in the world (OECD 2016). Reducing home bias—along the lines of the recent Government Pension Investment Fund reforms in Japan—could help raise the investment returns of these funds and secure more sustainable resources for aging societies.

## Structural Reforms: Retirement Systems

New financial products that help the elderly dissave their post-retirement savings (for example, reverse mortgages) or insure against longevity risks (for example, annuities) could lower the need for precautionary savings. The diverse demographic trends in Asia can also offer rich opportunities for cross-border risk sharing and financial integration.[32] For example, savings in late- or post-dividend countries seeking a higher return could be used to finance the large infrastructure gaps in early-dividend Asian countries (Ding, Lam, and Peiris 2014). Increasing the availability of "safe assets"—such as long-term government bonds or inflation-linked securities—can be especially attractive for pension funds and insurance companies (Groome, Blancher, and Ramlogan 2006).

[32]Financial integration in Asia remains low, especially given its high degree of trade integration—about 60 percent of Asia's exports and imports go to, or originate from, elsewhere within the region, while only 20 to 30 percent of cross-border portfolio investment and bank claims are intraregional, according to the April 2015 *Regional Economic Outlook: Asia and Pacific*.

## Box 2.1. Japan: At the Forefront of the Demographic Transition

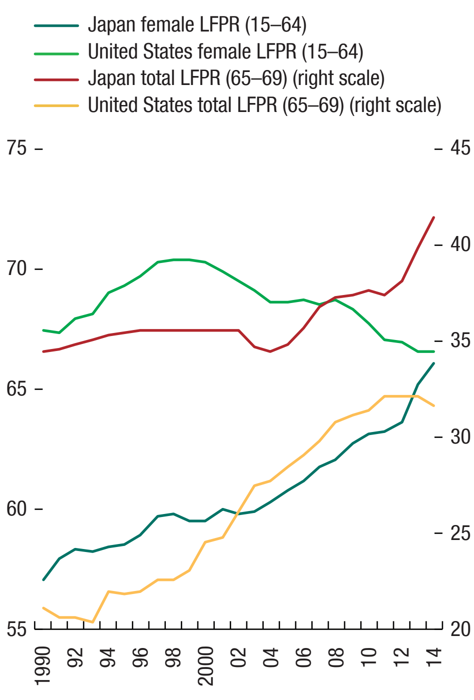
*Understanding the challenges Japan faces due to demographic trends is likely to be useful for other Asian countries going through their own demographic transitions. Japan's experience highlights how demographic headwinds can adversely impact growth, inflation dynamics, and the effectiveness of monetary policy.*

### Growth

Japan faces an unprecedented challenge from an aging and shrinking population. While the overall population started to shrink only after 2010, Japan's working-age population has been declining since 1997.

- **Working-age population**. The falling working-age population, together with the change in the overall labor force participation rate, reduced the Japanese labor force by over 7 percent between 1997 and 2016. A simple growth decomposition suggests that the negative impact on annual average growth has been about 0.3 of a percentage point.

**Figure 2.1.1. Labor Force Participation Rates for Female and Older Workers in Japan and the United States**
*(Percent)*




Sources: National authorities; and IMF staff estimates.
Note: LFPR = labor force participation rate.

- **Aging and productivity**. While older workers may enjoy higher productivity due to the accumulation of work experience, younger workers benefit from better health, higher processing speed, and the ability to adjust to rapid technological changes. Indeed, estimates by Liu and Westelius (2016) indicate that a 1 percentage point shift from the 30-year-old age group to the 40-year-old age group in Japan *increased* the level of total factor productivity by about 4.4 percent, while a similar shift from the 40-year-old to the 50-year-old age group *decreased* productivity by 1.3 percent.[1]

- **Labor force participation rate**. To counter these dynamics, the government has emphasized the need to raise the labor force participation rate of both female and older workers. Indeed, some progress has been made on this front. The labor force participation rate for women rose from 63 to 65 percent between 2011 and 2016, and the rate for workers ages 65 to 69 increased from 37 to 39 percent during the same time period. This compares favorably to other G7 countries, including the United States (Figure 2.1.1).

### Inflation

Japan's persistent struggles with episodes of deflation and consequent efforts to reflate the economy have also raised concerns that inflation dynamics may be linked to demographics. Shirakawa (2012) argues that as Japanese consumers and corporations gradually realize that demographic headwinds lower future growth—and thus expected permanent income—they cut back on current consumption and investment, triggering deflationary pressures. In contrast, Juselius and Takáts (2015) suggest

This box was prepared by Niklas Westelius.

[1]In addition to the direct impact on productivity, aging may also increase the relative demand for services (for example, health care) and thus cause a sectoral shift toward the less-productive services sector, leading to overall lower productivity in the economy.

**Box 2.1** *(continued)*

that aging may actually increase inflation as it constrains the labor supply—and thus production—while dissaving by retirees keeps demand relatively stable. However, in Japan such effects could be more than offset through a currency appreciation as retirees repatriate foreign savings (Anderson, Botman, and Hunt 2014). While empirical studies on the subject are relatively few (Yoon, Kim, and Lee 2014), some recent work on Japan shows that a 1 percentage point increase in the old-age dependency ratio reduces the inflation rate by about 0.1 of a percentage point (Liu and Westelius 2016).

**Effectiveness of Monetary Policy**

Finally, the secular stagnation hypothesis provides an additional channel through which adverse demographics can lead to both low inflation and low growth (Summers 2013). In particular, structural excess savings due to sluggish investment and high savings may lead to such a low neutral rate of interest that monetary policy can no longer stimulate the economy—causing the economy to operate below potential and thus keeping inflation below the central bank's inflation target. To the extent that Japan's demographic headwinds have changed the propensity to invest and save, they may have played an important role in the country's now over two-decade struggle with stagnant growth and low inflation.

**Need for Macro-Structural Reforms**

Japan's experience over the past two decades highlights the importance of addressing demographic headwinds in a proactive manner. While it is encouraging that the growth strategy under the "Abenomics" policy is to a large extent centered on overcoming demographic challenges, accelerated efforts are needed to enhance the labor supply (including by boosting female and older worker labor force participation and allowing for more foreign labor), reduce labor market duality, and increase private investment to boost growth prospects, increase monetary policy effectiveness, and support fiscal sustainability.

## Box 2.2. Fiscal Implications of Demographic Trends in Asia

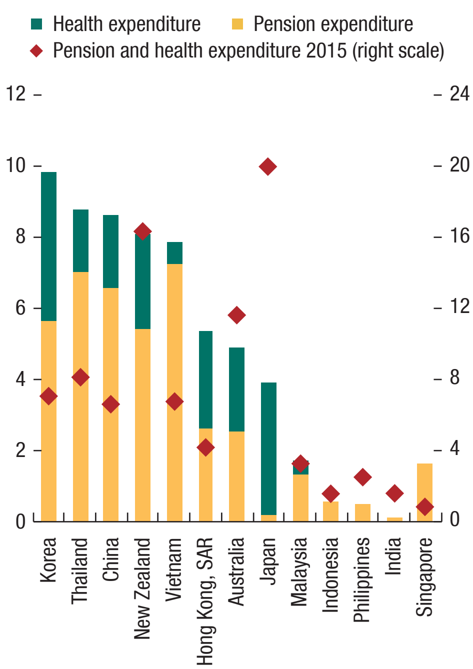
*Over the coming decades, Asia will experience significant demographic shifts with material fiscal implications that could limit fiscal space and raise vulnerabilities, absent policy measures.*

Under current policies, age-related public expenditures (pensions and health care) are projected to increase in many Asian countries, eroding public finances by up to 10 percentage points of GDP by 2050. In most cases, the increases would be driven by pensions (Figure 2.2.1).[1]

### Public Pensions

The projected increase in public pensions depends largely on each country's position in the demographic transition and the specific characteristics of its pension systems. In particular, the increase is likely to be higher in post- or late-dividend countries with a defined benefit system and lower in early-dividend countries or those with a defined contribution system (Table 2.2.1). In particular, for several countries in the late- or post-dividend stage (China, Korea, New Zealand, Thailand, and Vietnam), public pension expenditures could rise by more than 5 percentage points of GDP by 2050, absent policy measures. In contrast, for early-dividend countries (India, Indonesia, and the Philippines), these expenditures (as a percent of GDP) are expected to remain broadly unchanged.[2]

**Figure 2.2.1. Projected Age-Related Spending Increases**
*(Percent of GDP; change from 2015 to 2050)*




Sources: IMF staff estimates and projections based on United Nations, *World Population Prospects: 2015 Revision* (medium-fertility scenario); and Amaglobeli and Shi 2016.
Note: For Singapore, health expenditure projections are not available.

### Health Care

The increase in public health care expenditures depends largely on the rise in old-age dependency ratios and the generosity of the health care system. Absent reforms, health care expenditures in post-dividend countries with relatively generous health care systems (Korea and Japan) are projected to increase by more than 3 percentage points of GDP by 2050.[3] In Japan, Nozaki, Kashiwase, and Saito (2014) show that health care reforms could generate fiscal savings of 2 percent of GDP by 2030.

### Policies

Regarding *pensions,* the introduction of automatic adjustment mechanisms (AAMs) linking retirement ages (or retirement benefits) to life expectancy would be an attractive policy option, provided there is an adequate safety net for the elderly poor, whose life expectancy may be shorter than that of the average population. Although such rules have been introduced in many European countries, the use of AAMs in Asia to date remains limited, except for the case of Japan (Arbatli and others 2016). Regarding *health care*, policy options can be

This box was prepared by Jacqueline Pia Rothfels

[1]The calculations are based on the methodology outlined in Amaglobeli and Shi (2016). Additional age-related fiscal risks not covered in this analysis are potentially lower government revenues.

[2]Pension expenditures are projected as the product of four elements following Clements, Eich, and Gupta (2014): (1) the replacement rate (average pension over average output per worker); (2) the coverage ratio (share of pensioners in the population over 65); (3) the old-age dependency ratio; and (4) the inverse of the labor force participation rate.

**Box 2.2** *(continued)*

**Table 2.2.1. Characteristics of Asian Public Pension Systems, End of 2015**

| | | Position in Demographic Transition in 2015 | | |
|---|---|---|---|---|
| | | Early Dividend | Late Dividend | Post Dividend |
| | Defined Benefit | Philippines | New Zealand, Vietnam | Japan, Korea, Thailand |
| Risk Sharing | Defined Contribution | Indonesia | Malaysia, Singapore | Hong Kong SAR |
| | Mixed | India | Australia | China |

Sources: Arbatli and others 2016; and IMF staff estimates.
Note: The table describes the main pension system (covering the majority of workers) in each economy. In some economies with defined-benefit contribution systems, there may be smaller pension systems that operate on a pay-as-you-go basis, in the form of civil service pensions, social pensions, or minimum pension guarantees.

classified into three broad categories following Clements, Coady, and Gupta (2012): macro-level controls to cap spending (that is, regulating the price and quantity of health services); micro-level reforms to improve the spending efficiency of the health system (that is, promoting the use of generic drugs and preventative care); and demand-side reforms to curb health care demand (that is, higher patient copayments and premium contributions).

# Annex 2.1. Data and Methodology: Estimating the Impact of Demographic Trends on Growth and Financial Markets

## Demographics and Growth

### *Demographics and Labor Supply*

Based on United Nations World Population Prospects (the 2015 Revision, median-variant scenario), the aggregate labor force is projected as follows:

$$L_t = \Sigma_{j=1}^{J} N_t^j \, LFP_t^j \, E_t^j \, w_t^j$$

where $j$ indicates the age-gender cohort, $t$ indicates the year, $N$ is the number of individuals in each cohort, $LFP$ and $E$ denote cohort-specific labor force participation and employment rates, respectively, and $w$ is the weight factor to adjust for the difference between number of employees and the effective units of labor supplied.

### *Demographics and Labor Productivity*

**Methodology**: The methodology follows the approach of Aiyar, Ebeke, and Shao (2017), building on the work by Feyrer (2007). The baseline model fits the growth in real output per worker on the share of workers aged 55+ years and the combined youth and old dependency ratios, with decade (10 years) and country fixed effects. Specifically, the model takes the following form:

$$\Delta logYW_{it} = \theta_1 w55_{it} + \theta_2 DR_{it} + u_i + \eta_t + \varepsilon_{it}$$

where $i$ indicates the country and $t$ indicates the decade. $YW$ denotes real output per worker, $w55$ is the share of the total workforce aged 55–64 years, and $DR$ is the dependency ratio. $u_i$ is the country fixed effect, $\eta_t$ is the decade fixed effect, and $\varepsilon_{it}$ is the error term. Correcting for various econometric pitfalls—such as reverse causality—the approach measures the impact of workforce aging on output per worker. To address the endogeneity issue, the model also instruments the workforce share variable and the dependency ratio with lagged birth rates 10, 20, 30, and 40 years ago, similar to Jaimovich and Siu (2009).

The main authors of this Annex are Umang Rawat and Qianqian Zhang.

**Data**: The data sample spans the period from 1950 to 2014 and includes 12 Asian economies (Australia, China, Hong Kong SAR, India, Indonesia, Japan, Korea, Malaysia, New Zealand, the Philippines, Singapore, and Thailand) and more than 20 EU economies. The workforce and population data come from the United Nations (UN) and Organisation for Economic Co-operation and Development, while the output per worker data are from the Penn World Table 9.0.

**Results**: Running the approach for the combined Asian and European sample, we find that a 1 percentage point increase in the 55–64 age cohort of the labor force is associated with a reduction in total factor productivity of 0.74 of a percentage point (Annex Table 2.1.1).

### *Demographics and Capital Flows*

**Methodology:**[1] The EBA current account norm is estimated over period 1986–2013 using the general equation (Phillips and others, 2013; IMF, 2016):

$$CA = CA(X_S, X_I, X_{CA}, X_{CF}, Z, \Delta R)$$

where $X_S$ denotes the consumption/saving shifters, which include income per capita, demographics, expected income (shifts in permanent income), social insurance, the budget balance, financial policies, the institutional environment, and net exports of exhaustible resources; $X_I$ denotes the investment shifters, which include income per capita, expected income/output, governance, and financial policies; $X_{CA}$ denotes the export/import shifters, which include the world commodity-price-based terms of trade; $X_{CF}$ are capital account shifters, which

[1]Our EBA model is the same as introduced in the IMF Working Paper "The External Balance Assessment (EBA) Methodology" by Phillips and others (2013). Please see https://www.imf.org/external/pubs/ft/wp/2013/wp13272.pdf for more information.

**Annex Table 2.1.1. Panel Regression: Demographics and Labor Productivity[1]**

| Dependent Variables | Change in Real Output per Worker | Change in Real Capital Stock per Worker | Change in Human Capital per Worker | Change in TFP (model based) per Worker[2] | Change in TFP (from PWT 9.0) per Worker |
|---|---|---|---|---|---|
| Workforce Share | −0.612*** | 0.187*** | −0.0589*** | −0.740*** | −0.502*** |
| Aged 55–64 | (−5.309) | −4.144 | (−2.896) | (−4.714) | (−5.643) |
| Dependency Ratio | −0.122 | −0.105 | 0.0382 | −0.0549 | 0.279** |
| | (−0.695) | (−1.532) | −1.232 | (−0.229) | −2.057 |
| Observations | 571 | 571 | 571 | 571 | 571 |
| Number of Countries | 33 | 33 | 33 | 33 | 33 |

Source: IMF staff estimates.

Note: *t*-statistics in parentheses. TFP = total factor productivity.

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

[1]Results are qualitatively similar with country and year fixed effects panel regressions.

[2]Following a Cobb-Douglas function, the model takes the form of $\log(\textit{real output}) = \frac{a}{1-a}\log\left(\frac{\textit{real capital stock per worker}}{\textit{real output per worker}}\right) + \log(\textit{human capital per worker}) + \log(\textit{TFP per worker})$.

include indicators of global risk aversion, the "exorbitant privilege" that comes with reserve currency status, financial home bias, and capital controls; and $Z$ is the output gap and $\Delta R$ is the change in foreign exchange reserves.

**Current Account Norms**. The estimated current account equation includes a number of variables that are under policy control (fully or partially) in the near term: fiscal balances, capital controls, social spending, reserve accumulation, and financial policies (proxied by private credit). The observed values of these policies, along with other variables, contribute to the regression-predicted values of the current account. The fitted current account regression can be written as:

$$\widehat{CA} = \alpha + \boldsymbol{X}'\beta + \boldsymbol{P}'\gamma$$

where $\boldsymbol{X}$ is the vector of non-policy "structural" variables and $\boldsymbol{P}$ is the vector comprising the above policy variables measured by their actual values. Let $\boldsymbol{P}^*$ be the desirable values for those policy variables. The fitted equation can therefore be written as:

$$\widehat{CA} = \alpha + \boldsymbol{X}'\beta + \boldsymbol{P}^{*\prime}\gamma + (\boldsymbol{P} - \boldsymbol{P}^*)'\gamma$$

that is, the fitted $CA$ values from the regression can be decomposed into two parts:

- The first part, $(\boldsymbol{\alpha} + \boldsymbol{X}'\boldsymbol{\beta} + \boldsymbol{P}^{*\prime}\boldsymbol{\gamma})$, is the **EBA CA norm**, that is, the CA value implied by the regression if all policies were at desirable P* levels (and all other regressors were at their actually observed levels).
- The second term represents the *contributions of policy gaps* to explain deviations of the actual current account balance from the EBA norm. These policy gap contributions are measured as the product of each of the estimated coefficients on the respective policy variables by the policy gap ($\boldsymbol{P} - \boldsymbol{P}^*$).

We rely on current account norms for projections in this section.

**Demographic variables**: The demographic variables included in the regression include population growth, old-age dependency ratio, and two interaction terms between old-age dependency and aging speed, where old-age dependency ratio is defined as the ratio of population aged over 64 divided by population between 30 and 64 years old. Aging speed is the projected change in the old-age dependency ratio, 20 years out. Rel. old-age dependency ratio is the old-age dependency ratio divided by its GDP-weighted country sample average, in each year (same for Rel. aging speed). Coefficients on these variables are listed in Annex Table 2.1.2.

**Projections**: Projected changes in current account norm due to demographic transition are based on UN World Population Prospects (the 2015 Revision, medium-variant scenario).

**Annex Table 2.1.2. EBA: Demographic Variables**

| Variable Name | Coefficient | 1986–2015 |
|---|---|---|
| Population Growth # | −0.565 | −0.659* |
| Old-Age Dependency Ratio # | −0.057 | −0.091* |
| Rel. Old-Age Dependency Ratio × Aging Speed # | 0.130*** | 0.103*** |
| Rel. Aging Speed × Old-Age Dependency Ratio # | 0.088** | 0.106** |

Source: IMF staff estimates.

**Annex Figure 2.1.1. Old-Age Dependency Relative to World Average**

*(Percentage point difference)*


Sources: United Nations, *World Population Prospects: 2015 Revision* (medium-fertility scenario); IMF *World Economic Outlook*; and IMF staff projections.
Note: Old-age dependency is defined as the ratio of the population ages 65 and over divided by the population between 30 and 64 years old, in line with the External Balance Approach model. The world average is calculated on a GDP-weighted basis.

## Demographics and Financial Markets

### *Financial Markets*

**Methodology**: Three variables—youth dependency ratio, old-age dependency ratio, and aging speed—are used to capture different aspects of demographic transition and the effects on long-term interest rates, stock returns, and property prices. The baseline approach involves a panel regression on each dependent variable with country fixed effect. Specifically, the model takes the following form:

$$r_{it}/sr_{it}/pp_{it} = \beta_0 + \beta_1 YD_{it} + \beta_2 (YD_{it} \times COit) + \beta_3 OD_{it} + \beta_4 (OD_{it} \times CO_{it}) + \beta_5 AS_{it} + \beta_6 (AS_{it} \times CO_{it}) + \beta_7 RW_t + \gamma Controls_{it} + \varepsilon_{it} \quad (3)$$

where *i* indicates the country and *t* indicates the year. The three dependent variables are each denoted as *r*—10-year real interest rates, *sr*—year-over-year percent change in real stock returns, and *pp*—year-over-year percent change in real property prices.

Among the explanatory variables, *YD* and *OD* denote the youth dependency ratio (the ratio of population aged under 30 divided by population between 30 and 64 years old) and the old-age dependency ratio (the ratio of population aged over 64 divided by population between 30 and 64 years old), respectively, to account for the effects of changes in fertility and aging population on interest rates. *AS* denotes the aging speed (as defined earlier). These variables are also separately interacted with the capital openness index *CO* to analyze how openness of the economy affects the impact of demographic variables on interest rates. Another explanatory variable is *RW*, which denotes the world interest rate. The control variables (*Controls*) for the 10-year real interest rates model include the ratio of a country's GDP per capita to that of the United States, growth in labor productivity, and the cyclically adjusted primary balance. The control variable for both the real stock returns and real property price models includes the growth in labor productivity only. Lastly, $\varepsilon_{it}$ is the error term.

**Data**: The data sample spans the period from 1985 to 2013. Based on different data availability, the interest rates model captures 42 economies in the world,[2] the stock returns model captures

[2]The countries include Argentina, Australia, Austria, Belgium, Brazil, Canada, Chile, China, Colombia, Czech Republic, Denmark, Finland, France, Germany, Greece, Hong Kong SAR, Iceland, India, Indonesia, Ireland, Israel, Italy, Japan, Korea, Malaysia, Mexico,

14 economies,[3] and the property price model captures 56 economies.[4] The 10-year real interest rates and world interest rate data come from IMF (2014), King and Low (2014), and the IMF *World Economic Outlook*. The stock returns data come from *Global Financial Data*, and the property prices data come from the Bank for International Settlements. The demographics data come from United Nations, the labor productivity data come from Penn World Table 9.0, and the GDP and fiscal data come from the IMF *World Economic Outlook*. The capital openness index is based on the Chinn-Ito Index (2006).

**Results**: Running the three regressions gives the following result (Annex Table 2.1.3). On long-term interest rates and stock returns, the impacts of domestic demographic factors tend to diminish as the country becomes more open. On property prices, the effect of capital openness is small and insignificant, reflecting the local nature of the market.

Further, on long-term interest rates, we extend the approach by restricting $\beta_1 = -\beta_2$, $\beta_3 = -\beta_4$, and $\beta_5 = -\beta_6$. After the F tests show that we cannot reject these null hypotheses (Annex Table 2.1.4), we run an alternative specification, which takes the following form where denotations are the same as above:

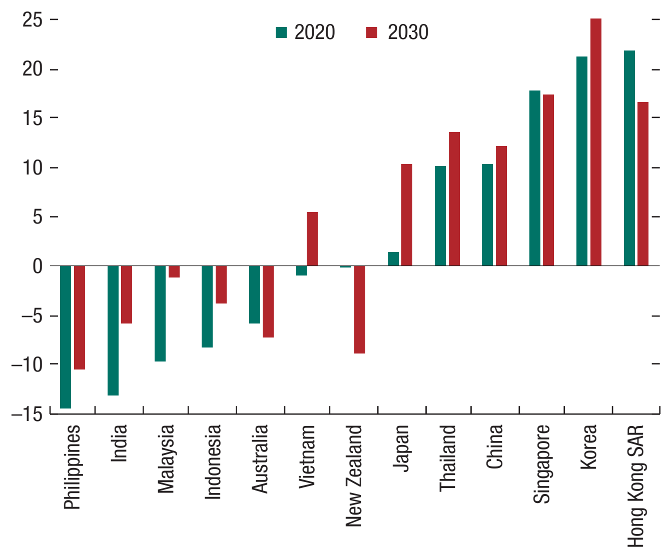
$$r_{it} = \alpha_0 + \alpha_1\, YD_{it} \times (1 - CO_{it}) + \alpha_2\, OD_{it} \times (1 - CO_{it}) + \alpha_3\, AS_{it} \times (1 - CO_{it}) + \alpha_4 RW_t + \mu Controls_{it} + \varepsilon_{it} \quad (4)$$

Netherlands, New Zealand, Norway, Peru, the Philippines, Portugal, Romania, Singapore, South Africa, Spain, Sweden, Switzerland, Thailand, Ukraine, United Kingdom, and United States.

[3]The countries include Australia, Canada, France, Germany, Italy, Japan, Korea, Malaysia, Netherlands, the Philippines, Sweden, Thailand, United Kingdom, and United States.

[4]The countries include Australia, Austria, Belgium, Brazil, Bulgaria, Canada, Chile, China, Colombia, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hong Kong SAR, Hungary, Iceland, India, Indonesia, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Macedonia, Malaysia, Malta, Mexico, Morocco, Netherlands, New Zealand, Norway, Peru, the Philippines, Poland, Portugal, Romania, Russia, Singapore, Slovak Republic, Slovenia, South Africa, Spain, Sweden, Switzerland, Thailand, Turkey, United Arab Emirates, United Kingdom, and United States.

**Annex Figure 2.1.2. Aging Speed Relative to World Average**
*(Percentage point difference)*




Sources: United Nations, *World Population Prospects: 2015 Revision* (medium-fertility scenario); IMF World Economic Outlook; and IMF staff projections.
Note: Aging speed is the projected change in the old-age dependency ratio over the next 20 years. World average is calculated on a GDP-weighted basis.

Combining with the results from (3) we find that the impacts of all youth and old-age dependency ratios and aging speed become almost zero as an economy becomes perfectly open. (Annex Table 2.1.5).

**Robustness**. Econometric analyses in Annex Tables 2.1.3 and 2.1.4 should be viewed with caution, because the explanatory demographic variables evolve slowly. We test for the presence of a unit root (with constant and trend) in demographics related variables and can reject the null of unit root in only one case.

When the explanatory variables have unit roots, there is a risk of a spurious regression problem resulting in incorrect statistical inferences. To evaluate the potential importance of this problem, the residuals from the baseline equation are tested for the presence of a unit root test. If the null hypothesis of a unit root in the residuals cannot be rejected, then the underlying regression model maybe misspecified. Annex Table 2.1.6 reports test statistics for the residuals based on the Fisher as well as the Im, Pesaran and Shin test, which reject the null hypothesis of unit root.

**Annex Table 2.1.3. Panel Regression: Demographics and Long-Term Interest Rates, Stock Returns, and Property Prices**

| Dependent Variables | 10-Year Real Interest Rate | Percent Growth in Stock Return | Percent Growth in Real Property Price |
|---|---|---|---|
| Youth Dependency Ratio | 9.41*** | 67.28*** | −11.32*** |
| | (2.46) | (23.66) | (3.96) |
| Youth Dependency Ratio × Capital Openness | −7.96*** | −31.01** | 0.67 |
| | (1.96) | (14.22) | (4.00) |
| Old-age Dependency Ratio | −18.3*** | −32.69 | −53.18* |
| | (6.28) | (82.26) | (31.77) |
| Old-age Dependency Ratio × Capital Openness | 17.04*** | 138.26* | −5.37 |
| | (5.77) | (75.02) | (26.99) |
| Aging Speed | −29.7*** | 315.31* | −100.95*** |
| | (11.06) | (163.18) | (34.05) |
| Aging Speed × Capital Openness | 25.89** | −317.04** | 60.79* |
| | (10.09) | (142.92) | (31.86) |
| World Interest Rate | 0.65*** | −1.18 | −1.48*** |
| | (0.16) | (2.17) | (0.53) |
| Growth in Labor Productivity | 0.07 | 4.75*** | 0.30 |
| | (0.06) | (0.98) | (0.20) |
| Ratio of GDP per Capita to that of the US | 2.38* | | |
| | (1.43) | | |
| Cyclically Adjusted Primary Balance | −0.00 | | |
| | (0.04) | | |
| Constant | 2.660*** | 10.15*** | 1.759*** |
| | (0.214) | (0.967) | (0.405) |
| Observations | 740 | 406 | 716 |
| Number of Groups | 42 | 14 | 56 |

Source: IMF staff estimates.

Note: Standard errors in parentheses. P denotes the *p*-value as the probability of obtaining a result equal to or more extreme than observed.
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Finally, given the low-frequency variation in demographic variables, annual real interest rates may introduce substantial noise to any relationship with demographic structure. Therefore, three and five-year returns for non-overlapping periods are constructed. Such multi-period returns are expected to emphasize the low-frequency variation in interest rates. The results (Annex Table 2.1.7) from these non-overlapping panels are similar to the baseline specification (Annex Table 2.1.3).

### *Natural Interest Rate*

**Methodology**. The natural rate is estimated using a time varying parameter VAR, which captures the co-movement between interest rates and trend growth in a flexible manner. We estimate a TVP-VAR for three variables—the growth rate of real gross domestic product, the inflation rate, and a measure of real interest rate. The natural interest rate is then extracted from the data using Wicksell's original definition of natural interest rate as the rate at which an economy is in a stable price equilibrium. Therefore, a long-horizon

**Annex Table 2.1.4. F Tests: Demographics and Interaction Variables**

| F tests |
|---|
| (1) Youth Dependency Ratio + Youth Dependency Ratio × Capital Openness Index = 0 |
| F (1, 688) = 0.65 |
| Prob > F = 0.4221 |
| (2) Old Dependency Ratio + Old Dependency Ratio × Capital Openness Index = 0 |
| F (1, 688) = 0.12 |
| Prob > F = 0.7276 |
| (3) Aging Speed + Aging Speed × Capital Openness Index = 0 |
| F (1, 688) = 1.69 |
| Prob > F = 0.1935 |

Source: IMF staff estimates.

**Annex Table 2.1.5. Panel Regression: Demographics and Long-Term Interest Rates**

| Dependent variables | 10-year real interest rate |
|---|---|
| Youth Dependency Ratio × (1 − Capital Openness) | 8.26*** |
| | (1.95) |
| Old-Age Dependency Ratio × (1 − Capital Openness) | −16.16*** |
| | (5.51) |
| Aging Speed × Capital Openness | −29.26*** |
| | (9.87) |
| World Interest Rate | 0.84*** |
| | (0.11) |
| Ratio of GDP per Capita to that of the US | 2.43* |
| | (1.39) |
| Cyclically Adjusted Primary Balance | 0.00 |
| | (0.04) |
| Growth in Labor Productivity | 0.07 |
| | (0.06) |
| Constant | −0.63 |
| | (1.57) |
| Observations | 740 |
| Number of Groups | 42 |

Source: IMF staff estimates.
Note: Standard errors in parentheses. P denotes the *p*-value as the probability of obtaining a result equal to or more extreme than observed.
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

**Annex Table 2.1.6. Null: Non-Stationarity (of order 1)**

| | | Fisher (modified inverse chi square test) | | | |
|---|---|---|---|---|---|
| **Variable** | Deterministic | Dickey Fuller | Phillips Perron | Im, Pesaran, Shin (t-value) | Result |
| **Real Interest Rate** | Constant | 3.23 | 4.77 | −1.34 | **I(0)** |
| | | *(0.00)* | *(0.00)* | *(0.09)* | |
| | Trend | 12.44 | 26.46 | −6.03 | **I(0)** |
| | | *(0.00)* | *(0.00)* | *(0.00)* | |
| **Youth Dependency** | Constant | 15.27 | 64.74 | 4.32 | **I(0)** |
| | | *(0.00)* | *(0.00)* | *(0.00)* | |
| | Trend | 8.25 | 10.00 | 0.26 | **Inconclusive** |
| | | *(0.00)* | *(0.00)* | *(0.60)* | |
| **Old Dependency** | Constant | 5.90 | −4.54 | 4.32 | **I(1)** |
| | | *(0.00)* | *(1.00)* | *(1.00)* | |
| | Trend | 11.56 | −2.30 | 0.01 | **I(1)** |
| | | *(0.00)* | *(0.99)* | *(0.50)* | |
| **Aging Speed** | Constant | 16.58 | −2.99 | −1.87 | **I(1)** |
| | | *(0.00)* | *(0.99)* | *(0.03)* | |
| | Trend | 6.58 | −1.04 | 1.11 | **I(1)** |
| | | *(0.00)* | *(0.85)* | *(0.87)* | |
| **World Interest Rate** | Constant | −6.00 | −5.95 | 10.61 | **I(1)** |
| | | *(1.00)* | *(1.00)* | *(1.00)* | |
| | Trend | −2.66 | −2.46 | 0.92 | **I(1)** |
| | | *(0.99)* | *(0.99)* | *−0.82* | |
| **Residuals** | | 17.80 | 14.82 | −7.14 | **I(0)** |
| | | *(0.00)* | *(0.00)* | *(0.00)* | |

Source: IMF staff calculations.
Note: Figures in parentheses are *p*-values for the test under the null hypothesis of nonstationarity. One lagged difference included.

**Annex Table 2.1.7. Long-Horizon Evidence on Demographic Structure and Real Rates**

| Dependent Variables | Annual Model | 3-Year Averages | 5-Year Averages |
|---|---|---|---|
| Youth Dependency Ratio | 9.41*** | 9.68*** | 9.33** |
| | (2.46) | (3.62) | (3.98) |
| Youth Dependency Ratio × Capital Openness | −7.96*** | −8.14*** | −7.20** |
| | (1.96) | (2.78) | (2.78) |
| Old-Age Dependency Ratio | −18.30*** | −21.10** | −17.00 |
| | (6.28) | (9.60) | (13.03) |
| Old-Age Dependency Ratio × Capital Openness | 17.04*** | 19.21** | 18.53* |
| | (5.77) | (8.56) | (9.47) |
| Aging Speed | −29.69*** | −25.56 | −35.48* |
| | (11.06) | (17.40) | (20.57) |
| Aging Speed × Capital Openness | 25.89** | 20.69 | 28.46* |
| | (10.09) | (15.67) | (17.07) |
| World Interest Rate | 0.65*** | 0.61** | 0.46 |
| | (0.16) | (0.24) | (0.52) |
| Growth in Labor Productivity | 0.07 | 0.06 | 0.02 |
| | (0.06) | (0.15) | (0.17) |
| Ratio of GDP per Capita to that of the US | 2.38* | 1.97 | 1.6 |
| | (1.43) | (1.48) | (3.01) |
| Cyclically Adjusted Primary Balance | −0.00 | −0.05 | 0.05 |
| | (0.04) | (0.10) | (0.08) |
| Observations | 740 | 271 | 166 |
| Number of Groups | 42 | 42 | 42 |

Source: IMF staff estimates.

Note: Robust standard errors in parentheses. P denotes the *p*-value as the probability of obtaining a result equal to or more extreme that observed.

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

forecast (5-year forecast) of the observed real rate is used as a measure of the natural rate of interest.

**Data**. The data sample spans from 1970:Q1 – 2016:Q4 and varies across countries based on availability. Real GDP, CPI inflation, and policy rates are sourced from Haver Analytics.

**Results**. Real natural interest rates have fallen significantly in the United States and some other advanced Asian economies, such as Japan, Korea, and Australia. Natural rates in emerging market economies, such as China, Malaysia, and Indonesia, are relatively stable.

## Literature Review on Demographics and Asset Returns

Existing studies seem to offer mixed findings on the empirical link between demographics and asset returns, depending on the specific sample and demographic variables used. In a series of prominent studies, Poterba (2001, 2004), for example, find evidence that U.S. households' asset holdings held outside defined-benefit pensions decline only gradually during retirement, and there is no significant relationship between aging and stock returns in the postwar U.S. data. On the other hand, Geanakoplos, Magill, and Quinzi (2004) and Davis and Li (2003) find that the middle-age-to-young ratio and the population share of prime saver group have significant positive relationships with real stock prices, respectively, in a group of advanced economies. On house prices, Engelhardt and Poterba (1991) show that the empirical relationship between real house prices and demographic variables in Mankiw and Weil (1989) from the U.S. data does not hold in the Canadian data. Meanwhile, Takats (2010) finds that in a group of 22 advanced economies, an increase in the change of old-age dependency significantly lowers real house price growth by about 66 basis points.

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