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HOW TO ASSESS FISCAL IMPLICATIONS OF DEMOGRAPHIC SHIFTS: A GRANULAR APPROACH

Over the next few decades, the world will experience significant demographic shifts, with material fiscal implications. In many advanced and emerging market economies, aging populations will lead to higher spending on pensions and health care. Moreover, projected population dynamics will adversely affect growth and government revenues. Building on and extending work by Clements and others (2015), this How-To Note presents a simple framework that can assist country teams in quantifying the effects of demographic changes from population aging on government fiscal balances. It includes two country applications of the framework and an associated template.

Key questions addressed by the note are:

- What are channels through which demographic changes could affect public finances?
- How can we quantify the fiscal impact of demographic changes?
- How can we tailor the assessment to country-specific circumstances?

Motivation and Overview

Significant demographic shifts are expected to take place in the world over the next few decades. In particular, the world population is projected to grow at a much slower pace and to become older. According to the UN's central scenario, the world population growth is projected to slow down from 1¾ percent per annum, as was observed during 1950–2015, to 0.6 percent during 2016–2080. As a result, the old age dependency ratio is projected to increase threefold between 2015 and 2100. For instance, the population of Europe will start shrinking already from 2021. Aging will also eventually affect less-developed countries, but unlike in most advanced and many emerging market economies, the impact will be felt much later.

These demographic changes will pose significant fiscal challenges. Unfavorable demographics are already affecting growth in some advanced economies, such as Japan, and in the EU. The expected population rebalancing and accompanying surge in age-related spending, which lower economic growth and potentially lower government revenues, will likely place considerable pressure on public finances going forward. While the near-term fiscal effects of these demographic developments are likely to be small, their long-term fiscal implications are significant. Moreover, given some degree of uncertainty surrounding specific demographic projections, an even faster demographic transition cannot be ruled out. Therefore, policymakers in countries affected by adverse demographic dynamics need to be cognizant of fiscal risks from demographic developments ahead of time.

Population aging will have a large direct impact on budgetary expenditures and revenues.

- *Expenditures*. Spending on old-age pensions and health and long-term care would rise. Given that pensions target specific age groups, as the share of the population within these age groups rises, so would pension spending. Although health care is universal across age groups, per capita health spending tends to increase with age. Therefore, aging will increase public health spending as well. Unlike pensions and health care, the potential impact of demographic changes on other types of spending (e.g., education) tends to be uncertain.[1] This expected increase in age-related spending could thus complicate tasks of countries still trying to put their public finances on a sustainable footing.
- *Revenues*. Individual income and consumption spending patterns tend to change over the life cycle.

Prepared by David Amaglobeli and Wei Shi with input from the Asia and Pacific and European Departments. Excellent research assistance was provided by Daria Ulybine.

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[1]While a smaller fraction of younger age groups could lead to some savings, higher enrollment rates and longer periods spent in education could put upward pressure on total education expenditure. Empirical evidence suggests that the direct budgetary impact of demographic changes on education spending is small (e.g., Grob and Wolter, 2007; McMorrow and Roeger, 1999).

For example, workers' incomes tend to increase from early in their careers until middle age and decline towards retirement. Consumption spending follows a similar pattern, although in the very early years of one's career consumption may exceed income (Thurow, 1969). Government revenues are likely to reflect these developments as well as changes in the overall size of the population. More generally, lower economic growth, following a slowdown in population growth and a shift in the age-gender structure towards less active cohorts, would translate into lower revenues, assuming unchanged policies.

This note provides practical guidance for analyzing the fiscal implications of demographic changes. The note builds on and extends Clements and others (2015) in several ways. First, it takes into account population heterogeneity in terms of labor force participation and employment rates and projects the impact of population aging and changes in total population size on output. The basic unit of analysis is a five-year cohort from the disaggregation of the population by age and gender. The focus on five-year age-gender cohorts allows us to capture the life-cycle behavior of labor supply: low for youth, increasing and flattening during prime age, and decreasing closer to retirement. Second, the accompanying template allows for modelling the effects of policy changes, such as increases in the retirement age and labor force participation rates, on government finances. Projected changes in long-term output and available long-term population projections are used to estimate government revenue and non-age expenditures. Third, regarding age-related expenditures, abstracting from any new policy changes (other than those already included in the current long-term projections), key policy variables such as the pension replacement rate are endogenously determined by changes in potential output. Fourth, the framework provides flexibility to adapt the analysis to country-specific circumstances, for example, by modifying assumptions on long-term revenue and non-age-related expenditure elasticities, and simulating the fiscal impact of different policy changes (e.g., changes in the retirement age or labor force participation rates). Finally, the template provides for sensitivity analysis by modifying underlying demographic projection scenarios.

The framework presented in the note is intended to complement available analytical tools for assessing the impact of demographic changes on public finances. The framework uses long-term projections for health care and pension spending available from other sources and then infers key parameters from these projections. This allows for simulating the effect of demographic changes as well as policy changes on public spending. For EU countries, projections developed by the European Commission aging working group are a good source as they are based on more granular information about population, pension and health care systems and current policies in a particular country. The framework outlined here could be used to complement existing sources or to develop projections where such information is unavailable.

Operationally, computing the impact of demographic changes on fiscal balances entails a number of steps.

- Long-term output is estimated based on the production function approach (growth accounting). In particular, aggregate employment is decomposed into population by age-gender cohorts, cohort-specific labor force participation and employment rates, and hours worked. The size of each age-gender cohort is driven by population growth, which in turn depends on the rates of fertility, mortality and migration. The resulting change in the age composition of the working-age population affects aggregate labor force participation, employment rates, and total hours worked, thereby affecting total employment. Cohort-specific labor force participation and employment rates are estimated from historical data. These estimates, in combination with cohort-specific average weekly hours supplied and data on the demographic distribution, are used to compute aggregate labor.
- Long-term projections for potential GDP are used to estimate aggregate budgetary revenues. In this simple framework, which abstracts from age-specific tax liabilities, the impact of population aging on government revenues manifests itself through changes in population size and structure, and hence potential output. As a benchmark, tax revenues are assumed to remain stable as a share of GDP—as the labor force shrinks, tax revenues and GDP are expected to fall by the same proportion. However, changes in the structure of tax systems resulting from aging could justify the use of revenue elasticities different from one. Therefore, the framework offers flexibility in setting different revenue elasticities.
- The impact of demographic changes on pension and health care expenditure is assessed using projections

Box 1. Behavioral Responses to Demographic Changes

Changes in the age structure of the population could trigger various behavioral responses and significantly alter government policies.

- Increases in life expectancy could encourage individuals to stay in the workforce longer or induce governments to increase labor force participation of older-aged cohorts. However, despite a significant increase in life expectancy, in most OECD countries the increase in effective retirement age has been more modest (Bloom and others, 2010).
- Increased life expectancy could encourage larger savings during the working life in order to finance a longer retirement (Bloom and others, 2003) and lower interest rates (Kulish and others, 2006), which could encourage capital accumulation. However, this effect could be more than offset by dissaving by the elderly (Lee and others, 2010).
- Labor supply could increase as a reaction to wage increases resulting from labor scarcity (Dolls and others, 2015). However, the decline in population could also reduce labor supply and aggregate demand for goods and services, which, in turn, could lower the demand for labor.
- The decline in fertility could encourage higher female labor force participation (Bloom and others, 2007), but unleashing the full potential would require a comprehensive set of policies to support and promote female employment (Elborgh-Woytek and others, 2013).
- Lower fertility could increase investment in human capital, raising labor productivity, which could more than offset the potential loss in output from the decline in population size (Lee and Mason, 2010).
- International economic flows could be affected, with capital flowing from countries with older populations to countries with younger populations (Borsch-Supan, 2002).
- The capacity to innovate could change with aging with empirical evidence pointing to an inversely U-shaped relationship with the highest performance shown between ages 30 and 50, depending on domain (Frosch, 2009).
- The political behavior of an aging electorate could reshape policies to better favor the interests and needs of older populations (Peterson, 1999) or resort to replacement migration policies (Tyers and Shi, 2007).

developed by Clements and others (2015).[2] In particular, these projections are used to derive country-specific information on benefit and coverage ratios based on the expected evolution of age-dependency ratios and labor force participation rates. By doing so, estimates of labor force participation rates and output per worker are assumed to be endogenous. Potential cumulative liabilities associated with the age-related expenditure are calculated as the net present value of pension and health care spending.

The framework presented here and the accompanying template allow for estimating the impact of demographic developments under different scenarios. For example, a status quo scenario that assumes unchanged population size and age structure from its current levels could be contrasted against available population projection scenarios, which assume different trajectories for fertility, mortality and migration. The impact on fiscal balances can then be calculated as the difference between these scenarios. Moreover, the framework allows for simulating the effect of various policy changes (e.g., specific changes in labor market policies that affect participation and employment rates, such as a reduction in the gender gap, or reforms to age-related spending programs). The template also offers flexibility in selecting the most appropriate scenarios from the various population projection scenarios and conducting sensitivity analysis.

A number of caveats are in order. First, this simple framework abstracts from changes in behavioral responses, which can be difficult to quantify (Box 1). While model-based methods can capture such responses, they tend to be computationally more challenging. Second, the links between demographics and growth are numerous and subject to considerable uncertainty. For example, population aging can have a positive impact on economic growth if it triggers additional savings or investments in R&D, while leaving the size of the workforce unchanged (Futagami and Nakajima, 2001; Prettner, 2009).[3] Finally, the projected size and long-

[2]The methodology used to quantify the impact of demographic and other factors on health spending is discussed in Clements and others (2012). The parameters of different pension schemes and trends in pension expenditures are presented in Clements and others (2014).

[3]See Pretner and Prskawetz (2010) for a survey of literature on demographic change in models of endogenous economic growth.

term age composition of the population are subject to considerable uncertainty. Future realizations of fertility, mortality, and migration could differ substantially from projected levels, with a significant bearing on estimated age-related spending (Clements and others, 2015). Notwithstanding these considerations, the tractable framework described in this note offers useful insights into the potential impact of various demographic scenarios on governments' future fiscal positions.[4]

The rest of the note is organized as follows. The second section presents the basic framework for assessing the impact of demographic changes on fiscal variables. The third section presents two country case studies. The case study on Korea demonstrates the fiscal costs of expected population aging and potential savings obtained from eliminating the large gender gap in labor force participation. The example of Poland illustrates flexibility in using the analytical framework to assess the implications of changes in pension system parameters. The fourth section briefly discusses policy implications. Annex 1 provides some practical tips for using the accompanying template and interpreting the figures it generates.

Analytical Framework for Assessing Fiscal Effects of Demographic Changes

We present a simple framework for assessing the impact of demographic changes on fiscal balances. The methodology relies on tracing the effects of changes in the size and age-gender composition of the population on key fiscal variables of interest. The size of the impact on fiscal balances resulting from demographic changes is assessed relative to a hypothetical scenario that assumes the size and the age-gender composition of the population to remain unchanged from their 2015 levels during the entire projection horizon. The baseline scenario assumes more realistic population developments, derived from the UN World Population Prospects (the 2015 Revision; see Box 2). The impact of an aging population on revenue and expenditures is isolated by holding all other factors constant. This implies estimating the difference in expenditure and revenue between two different demographic scenarios.

Estimating Growth Impact

A production function approach is used to estimate long-term output, taking into account demographic developments. Following the standard specification of the Cobb-Douglas production function with constant returns to scale, output can be expressed as the product of basic factor inputs and productivity. Specifically,

$$Y_t = TFP_t \times K_t^{1-\beta} \times L_t^{\beta} \quad (1)$$

where Y_t is real output, TFP_t is the total factor productivity, K_t is the stock of capital, L_t is the aggregate labor, and β is the share of labor in output. Following EC (2015) and IMF (2015), age-gender cohort-specific information is used to decompose aggregate employment (L_t) into four elements.[5] In particular, rewriting equation (1) in logarithmic terms, output is expressed as:

$$Log(Y_t) = Log(TFP_t) + (1 - \beta) \times \text{Log}(K_t) + \beta \times Log \sum_{j=1}^{j} N_t^j \times LFP_t^j \times E_t^j \times w_t^j \quad (2)$$

where j indicates the age-gender cohort, 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 the number of employees and the effective units of labor supplied.[6]

Equation (2) can be used to obtain historical total factor productivity (TFP) estimates.[7] Historical labor force participation and employment rates for each age-gender cohort are combined with the evolution of the size of each individual cohort and actual hours worked by each cohort to estimate aggregate labor. The coefficient β can be obtained by calculating the share

[4]A few other studies look at the relationship between demographic changes and government finances. The European Commission has developed two medium-term sustainability indicators to assess the impact of age-related spending in European countries (EC, 2012). Velculescu (2010) derived alternative forward-looking indicators of fiscal sustainability using the public sector's intertemporal net worth. Auerbach and others (1998) present generational accounting as a method for long-term fiscal analysis and planning.

[5]A population's age and gender composition has a significant impact on spending. For example, in the case of Korea, the projected long-run pension and health expenditure under the UN medium-fertility scenario will be higher by ½ and 1 percent of GDP per annum, respectively, if aggregate labor is simply approximated by the change in working-age population.

[6]In the country case studies, an adjustment based on average hours worked for each cohort is assumed due to data limitations. Other desirable weights would be to adjust for labor productivity, possibly utilizing the average education attainment for each cohort as a proxy. The literature shows that labor productivity significantly differs across age groups (e.g., Göbel and Zwick, 2009; Skirbekk, 2003).

[7]It should be noted that TFP is measured as a residual, and any measurement errors in the labor and capital series will be captured in the estimate of TFP.

Box 2. Data Used for the Country Analysis

Different population scenarios can be derived from the UN World Population Prospects (the 2015 Revision). The database contains five-year age-gender cohort historical estimated headcounts at an annual frequency for 1950–2015, and projections for 2016–2100 for 189 countries. The projections are based on eight different scenarios that have been developed by varying fertility, mortality and international migration assumptions. The UN's central projection is the medium-fertility variant scenario. This can be considered as the most probable scenario and assumes a decline of fertility for countries where large families are still prevalent as well as slight increase in fertility in countries with fewer than two children per woman on average. Other scenarios include high, low, and constant fertility, instant-replacement-fertility, zero-migration, constant-mortality and no-change (i.e., constant-fertility and constant-mortality).

Detailed labor market information is obtained from the Organisation for Economic Co-operation and Development (OECD). It includes data on labor market participation and employment for each age-gender cohort. Data on average hours worked for broadly defined age-gender cohorts is used to account for differences between the number of workers and actual hours supplied. The OECD and IMF also provide national accounts data. Both sources could be used for growth-accounting exercises.

Data on age-related spending are obtained from the IMF and OECD. Specifically, Clements and others (2015) provide the benchmark projections for pension and health care spending. Underlying these projections are the UN's population projections under the medium-fertility variant scenario. Health spending by age for a group of OECD countries is taken from De la Maisonneuve and Martins (2013).

of the wage bill in GDP.[8] Capital stock is estimated using the perpetual inventory method, with the capital stock in each period equal to net capital formation plus the estimated stock in the previous period (equation 3).

$$K_t = (1 - \delta) \times K_{t-1} + I_t \quad (3)$$

Using equation (2) and TFP estimates, long-term projections for potential GDP are calculated under different demographic scenarios. Aggregate labor is assumed to evolve in line with total population and its age-gender composition under different demographic scenarios. Specifically, over the projection period, age- and gender-specific labor force participation and employment rates are assumed to follow the average of trend rates for the past five years.[9] For example, an increase in the relative size of the age-gender cohort with lower labor force participation and employment rates will contribute to the reduction in aggregate labor force participation and employment rates. Abstracting from policy changes, TFP is assumed to grow at its historical average trend rate, while capital accumulation is assumed to follow the balanced-growth condition:

$$1 + g_t^K = (1 + g_t^{TFP})^{1/\beta} \cdot (1 + g_t^L) \quad (4)$$

Based on these assumptions of a constant capital-to-labor ratio (expressed in efficiency units) and TFP unchanged from its historical average, different population projections scenarios give rise to different paths of aggregate labor and thus final output.[10]

Estimating Revenue Impact

The impact of demographic changes on government revenues is closely related to the projected potential output. We assume that government revenue remains at its historical level as a share of GDP, which in turn is mainly driven by potential output, without assuming any changes in tax policy or tax administration. In other words, lower output resulting from worsening demographics would lead to proportionally lower revenues. However, it is worth mentioning that demographic developments could give rise to revenue-

[8]Alternatively, this parameter could be obtained from the Penn World Tables or other country-specific estimates.

[9]These trend rates are obtained by removing cyclical fluctuations using the Hodrick-Prescott filter.

[10]These are clearly simplifications, as demographic factors could also affect productivity (see, for example, Feyrer, 2007) and investment (see, for example, Higgins, 1998).

to-GDP elasticities that are different from one. In particular, aging could trigger changes in the composition of tax revenue. This could be done, for example, by increasing the share of capital and property taxes. An increase in tax revenue (as a share of GDP) is also possible due to the fact that older age groups continue paying income taxes and consumption taxes without contributing to output.[11]

An alternative, more data-intensive, approach is to estimate revenues based on age-specific tax liability profiles of taxpayers (e.g., Felix and Watkins, 2013; Lee and Edwards, 2002). Incomes and taxes paid tend to be lower in early years of taxpayers' working lives, and increase thereafter. For example, in the US the average income of individuals in the 45–54 age cohort was 1.4 times higher than the one for those in the age cohort of 25–34 in 2011. The progressivity of the income tax system is another important factor determining tax liabilities of age cohorts. Consumer spending and related taxes (sales tax, value-added tax, excises) typically strongly correlate with incomes, a relationship that could be used to account for demographic developments. Such an alternative approach would involve collecting data on per capita tax liabilities for income, consumption, and property taxes, as well as social security contributions. It would also involve producing long-term projections under different population scenarios.

Estimating Age-Related Spending

Pension spending as percent of GDP is decomposed into four key elements and expressed as an identity (following Clements and others, 2014). These components are: (i) the replacement rate (RR), which is calculated as the average pension over average output per worker; (ii) the coverage ratio (CR), which measures the share of pensioners in the total population above the retirement age (above 65); (iii) the old age dependency ratio (ODR), which is measured as the ratio of population above 65 to the working-age population (15–64); and (iv) the inverse of labor participation (LP), defined here as the share of workers in the total working-age population—different from the definition of labor force participation in (2).

$$PE = RR \times CR \times ODR \times \frac{1}{LP} \tag{5}$$

where

$$PE = \frac{Pension\ expenditure}{GDP};\ RR = \frac{PE/pensioners}{GDP/workers};$$

$$CR = \frac{Pensioners}{Popul\ 65+};\ ODR = \frac{Popul\ 65+}{Popul\ 15-64}$$

$$LP = \frac{Workers}{Popul\ 15-64}$$

Each of the four terms in (5) is influenced either by demographics or by policy changes. The replacement rate in this framework is endogenously determined as it is indirectly affected by changes in demographics through changes in GDP per worker. It can also be affected by pension policies that alter the generosity of pension benefits.[12] The coverage ratio could be affected by government policies that change statutory retirement ages.[13] Similarly, labor participation could be influenced by specific labor market policies, as well as demographic trends. Again, abstracting from policy changes, the labor participation rate in this framework depends on relative changes in the size of specific age-gender cohorts.

Health care spending is expressed as the product of three elements (following Clements and others, 2015). These are: (i) relative generosity of the health care package for the younger population expressed as per capita health cost for younger population divided by the per worker GDP (GHP); (ii) the inverse of the labor participation (LP) rate for the population between 0 and 64 years of age; and (iii) the dependency ratio (DR) times a coeffecient (α). The latter measures the ratio of per capita health cost for the older population to per capita health cost for the younger population.

[11]For example, the UK's Office for Budget Responsibility projects more than a proportional increase in revenues relative to GDP on account of older groups continuing to pay income taxes (on pensions), value-added taxes, and capital taxes, even though they are not directly contributing to GDP via earnings (Office for Budget Responsibility, 2015).

[12]The impact of aging on fiscal balances could be mitigated when pension systems include second-pillar-funded schemes. Additional spending pressures may still emerge if the size of pension benefits implies a significant decline in replacement rates.

[13]The coverage ratio could also be affected by long unemployment spells, say for the young during the recent global financial crisis. Such individuals may not be able to accumulate enough service years to qualify them for a pension and therefore drop out of the pension system. Moreover, in countries with less developed public pension systems with limited coverage, the projections for the coverage ratio could explicitly take into account the reform of the pension system which expands the net of the public pension system.

$$HE = GHP \times \frac{1}{LP} \times (1 + \alpha \times DR) \qquad (6)$$

where

$$HE = \frac{Health\ expenditure}{\text{GDP}}; \; GHP = \frac{\frac{HE_{0-64}}{Popul\ 0-64}}{\frac{\text{GDP}}{\text{Workers}}};$$

$$LP = \frac{Workers}{Popul\ 0-64}; \; \alpha = \frac{\frac{\text{HE}_{65+}}{Popul\ 65+}}{\frac{HE_{0-64}}{Popul\ 0-64}};$$

$$DR = \frac{Popul\ 65+}{Popul\ 0-64}$$

Similar to pension expenditure projections, each term of (6) is affected either by policy changes or by demographics. In addition to its *direct* effect through changes in dependency ratio and labor participation rates, population aging also affects the generosity of the health care package *indirectly* through growth. The coefficient α is exogenously determined and could be calculated from available sources. Data on public health care expenditure is available for a group of OECD countries from De la Maisonneuve and Martins (2013). If no country-specific information is available, the average for countries at similar income levels could be used.[14]

Using available long-term pension and health care spending projections, spending levels under different demographic scenarios are calculated. Specifically, projections for age-related spending are drawn from those in Clements and others (2015), which are based on population projections under the UN's medium-fertility scenario. These projections take into account already implemented or intended policy reform measures. Projections for dependency ratios and labor force participation rates, which are key variables of interest, will vary across different demographic scenarios. To isolate the demographic effects, the size of the average pension and the generosity of health care package, the coverage of the public pension system and the α coefficient are kept constant across scenarios, implying no policy measures.[15]

[14] The α coefficient could be estimated as the weighted average of public health care expenditure for age cohorts 65 years and above divided by the weighted average of public health care expenditure for younger cohorts. The relative size of each age cohort could be used as weights. Using this approach, the α coefficient is expected to gradually rise over time as the share of older cohorts in the group 65 years and above increases. According to the available country-specific data, public health care per capita GDP costs continuously rise after the age of 45.

[15] The generosity of the health care package per capita for younger population ($\frac{HE_{0-64}}{Popul\ 0-64}$) could grow faster than per worker GDP when inflation of health services and medicines exceeds overall inflation. If this is the case, GHP projections could be adjusted accordingly.

Putting It All Together

The last step involves estimating net effects on fiscal balances resulting from demographic changes. These effects can be grouped into revenue, non-age- and age-related expenditures. While the latter are directly obtained from the analysis above, revenue and non-age-related expenditure are calculated using their long-term output elasticities (see Box 3). For simplicity, long-term elasticities for both revenue and non-age-related expenditure relative to output are set to one, implying that they grow in line with economic growth. There might be instances when elasticities could be different from one. For example, Peterson (1999) argues that some government expenditures (e.g., defense) may not decline with population. Assuming different elasticities, revenue and non-age-related expenditures can be calculated as: $\frac{R}{R^*} = \left(\frac{Y}{Y^*}\right)^{\varepsilon_R}$, $\frac{E}{E^*} = \left(\frac{Y}{Y^*}\right)^{\varepsilon_E}$. Box 4 discusses different ways to use the framework.

The impact on fiscal balances resulting from demographic changes can be calculated as the difference between two population scenarios. For instance, the impact could be assessed by comparing the projected fiscal balance under the most likely population scenario with that under a scenario that assumes constant demographics. Differences in fiscal balances between these two scenarios can be shown in percent of respective GDP (to highlight the impact relative to the size of the economy) and the constant demographics scenario GDP to illustrate the absolute magnitude of the fiscal impact.

The flow variables obtained from above could be used to calculate the stock of prospective cumulative liabilities. The potential cumulative liabilities associated with the age-related expenditure can be calculated as the net present value of pension and health care spending from the current year (2015) onwards:[16]

$$\sum_{t=2015}^{2100} \frac{PE_t + HE_t}{(1 + r_t)^{(t-2015)/5}} \triangleq E_{2015}^{AGE} = x \sum_{t=2015}^{2100} \frac{1}{(1 + r_t)^{(t-2015)/5}} \qquad (7)$$

Equation (7) also illustrates how to construct the constant flow of age-related liabilities, which needs to be financed by the aging society.

[16] The medium- and long-term indicators (S1 and S2) reported in the EC's Fiscal Sustainability Report deal with age-related spending in a similar manner. However, their construction requires more information, such as the current and future targeted debt level and current fiscal policy stance, to assess fiscal sustainability.

Box 3. Assumptions Underpinning Estimates

In the accompanying template, parameters such as the capital depreciation rate, long-term revenue and expenditure elasticities, medium-term and long-term interest rates (to compute the net present value of the age-related expenditure) and the health spending per person aged 65 and above relative to the rest of the population are set by default but can be modified at the user's discretion.

- The capital stock depreciation rate, which is used for the historical growth-accounting exercise, is set at 5.9 percent per year in line with Nadiri and Prucha (1993).
- Long-term revenue and non-age-related expenditure elasticities are set at one.
- Long-term interest rates are set at 2.6 percent in line with Giglio and others (2015). Alternatively, real discount rates suggested by the US Office of Budget and Management (2003) as part of the guidance to federal agencies for regulatory analysis, which are in the range of between 3 and 7 percent, could be used.
- The default ratio of per capita health spending of individuals older than 65 years relative to those younger than 65 years is 3.5, which is the average for a group of OECD countries for which data were available (De la Maisonneuve and Martins, 2013). Alternatively, estimates of country-specific ratios from the country authorities could be used.

Box 4. Alternative Options to Analyze the Fiscal Impact of Demographic Changes

The approaches presented in the note are not the only way to assess the fiscal impact of demographic changes, and certain aspects could be further refined or modified (Appendix 2). More specifically:

- *Estimating output*. Assumptions used to estimate potential output (equation 2) could be better adapted to country-specific circumstances. This could involve modifying assumptions about the capital depreciation rate, projected TFP growth rate, capital accumulation (by relaxing the balanced-growth condition), and discount rates and projecting cohort-specific labor force participation and employment rates based on models or using available projections from the ILO. For example, when projecting labor force participation rates, the analysis could consider the presence of hysteresis effects, which could show up in permanently low labor force participation rates for certain cohorts.
- *Estimating age-related spending.* Rather than using available long-term pension and health care spending projections to impute key policy terms from equations (5) and (6), age-related spending could be projected by targeting specific levels for these policy-driven terms. For example, after deriving actual pension replacement and the coverage ratios, the specific paths for these two variables for the entire projection period could be determined.

Country Case Studies

Two country applications below illustrate the framework and its analytical flexibility when tailored to address policy-relevant questions. Both Korea and Poland are expected to experience large changes in their demographic structures in the coming decades. Under the central population projection scenario (the UN's medium-fertility scenario), both countries will see their populations shrink and age significantly. Massive shifts in the size and age structure of the population are expected to slow output growth, while age-related spending is expected to surge. The fiscal costs of demographic changes, calculated as the difference in fiscal balances between the medium-fertility scenario and a scenario based on unchanged demographics, are estimated at 8½ percent of GDP for Korea. The case of Poland illustrates how an increase in the projected level of the pension replacement rate and a decrease in retirement age would significantly push up pension expenditure.

Korea

For Korea, we use the framework and accompanying template to produce standardized charts and an analysis that captures granular, country-specific information.

Background

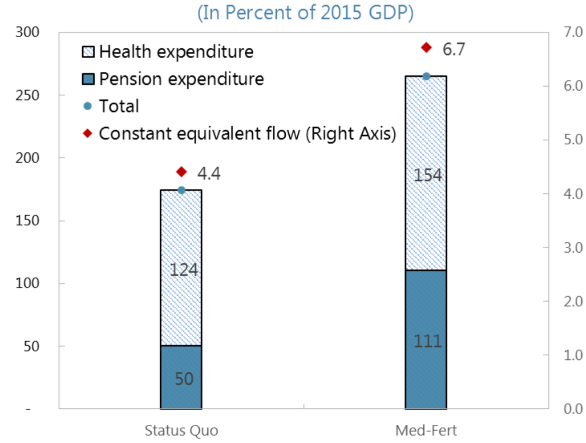
Korea's population is projected to shrink and age rapidly under most population scenarios (Figure 1). If fertility remains at its current level, which at 1¼ children per woman is one of the lowest in the world, and mortality rates remain unchanged, the Korean population would more than halve by 2100. However, the UN's medium-fertility variant scenario assumes that fertility will gradually accelerate over the coming decades, limiting the decline in population to slightly above 20 percent of its 2015 size. At the same time, the population is expected to rapidly age. By 2050, Korea is expected to be the country with the oldest population in the world, with a median age of 54 years. The old-age dependency ratio is expected to increase more than fourfold by 2065.

Historically, labor has been an important contributor to output growth in Korea. The labor contribution to growth was particularly high from 1980 until the financial crisis of 1997–98 (averaging 1¼ percentage points). After the financial crisis, the labor contribution dropped to around 0.6 percentage point of GDP. Moreover, output growth declined from close to 9 percent in 1981–97 to around 4 percent in 1998–2014, and is expected to decline further in the coming decades. Under the medium-fertility scenario, trend growth is projected to fall to about 2.0 percent by 2040 and then rebound to 2.5 percent after 2080, reflecting the population growth developments. An increase in the labor force participation rate in the next 20–25 years is expected to somewhat mitigate the effect of a declining population.

Assessing Fiscal Effects of Demographic Changes

To assess the fiscal impact of demographic changes we examine two scenarios (Figure 2). The first is a status quo or unchanged scenario, where the size and the age-gender composition of the population are assumed to remain unchanged from their 2015 levels during the entire projection horizon. The second is the most probable scenario based on demographic trends in line with the UN's medium-fertility variant scenario. At less than 3 percent of GDP, current public pension spending in Korea is relatively low by international comparison. However, pension spending is expected to increase to its peak of 6.5 percent of status quo GDP by 2050 (8.1 percent of the GDP estimated under the medium-fertility scenario). Similarly, health care spending under the medium-fertility scenario is projected to exceed 8 percent of the status quo scenario GDP by 2050 compared with 5.8 percent of GDP under the status quo scenario. These trends largely reflect a sharp rise in old-age dependency ratios. Sensitivity analysis (Figure 3) shows that under the low-fertility scenario, age-related spending could exceed spending under the medium-fertility scenario by about 7 percentage points of GDP. Moreover, if the current large gap between male and female labor force participation rates closes by 2100, total age-related spending would be about 3 percentage points of GDP lower.

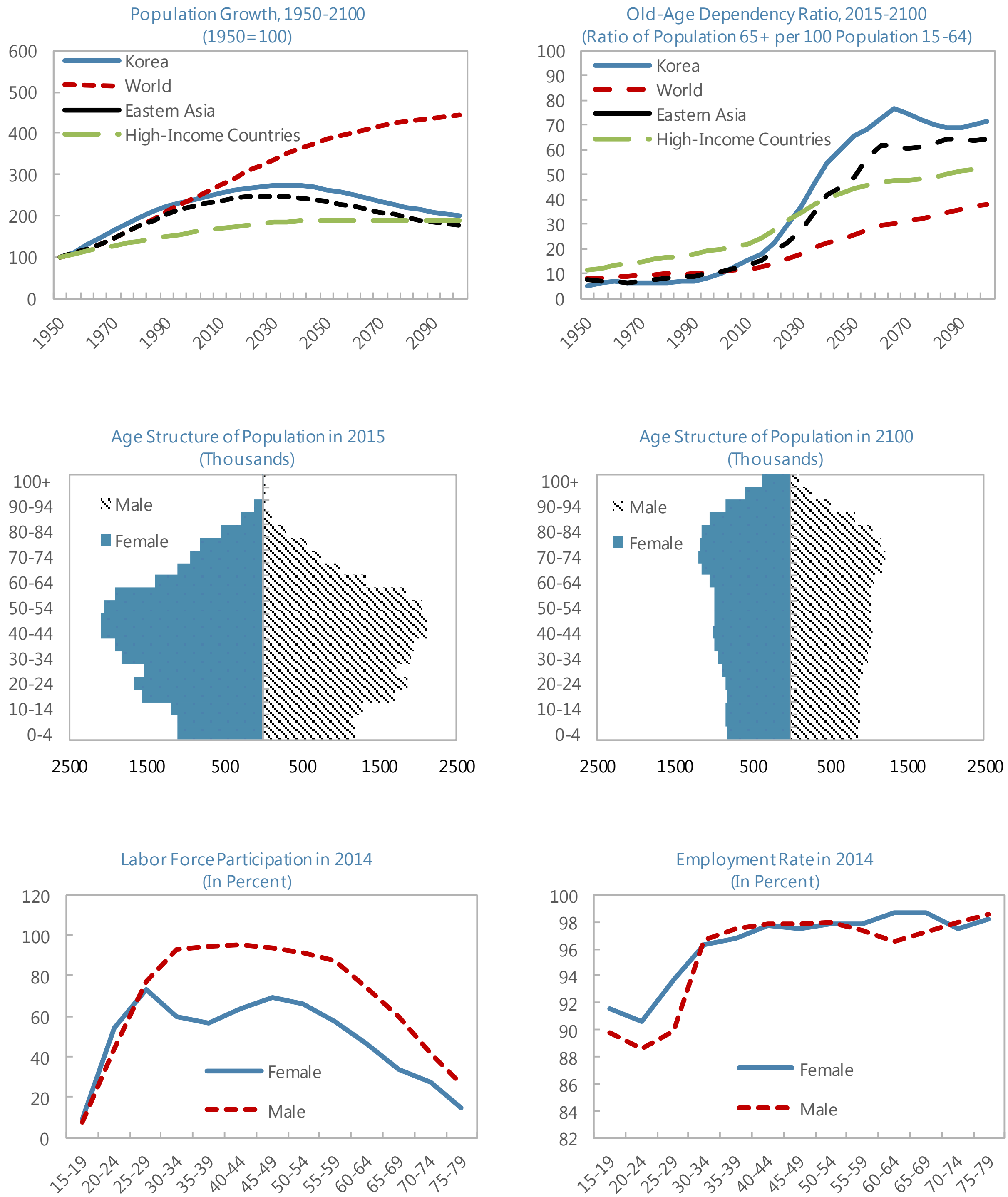
Korea: Age-Related Stock
(In Percent of 2015 GDP)



Consistent with the projected demographic trends, the fiscal deficit in Korea is expected to continuously widen until 2050. The deterioration in the fiscal balance relative to the status quo scenario is expected to be gradual. The contribution of demographic factors to the widening of the fiscal deficit is estimated to be 0.7 percent of the status quo GDP by 2020, reaching about 8½ percent of status quo GDP by the 2050s. Large differences in the stocks of discounted future age-related flows, estimated at 91 percentage points of 2015 GDP (see text chart), are another indication of the severe implications of demographic changes.[17]

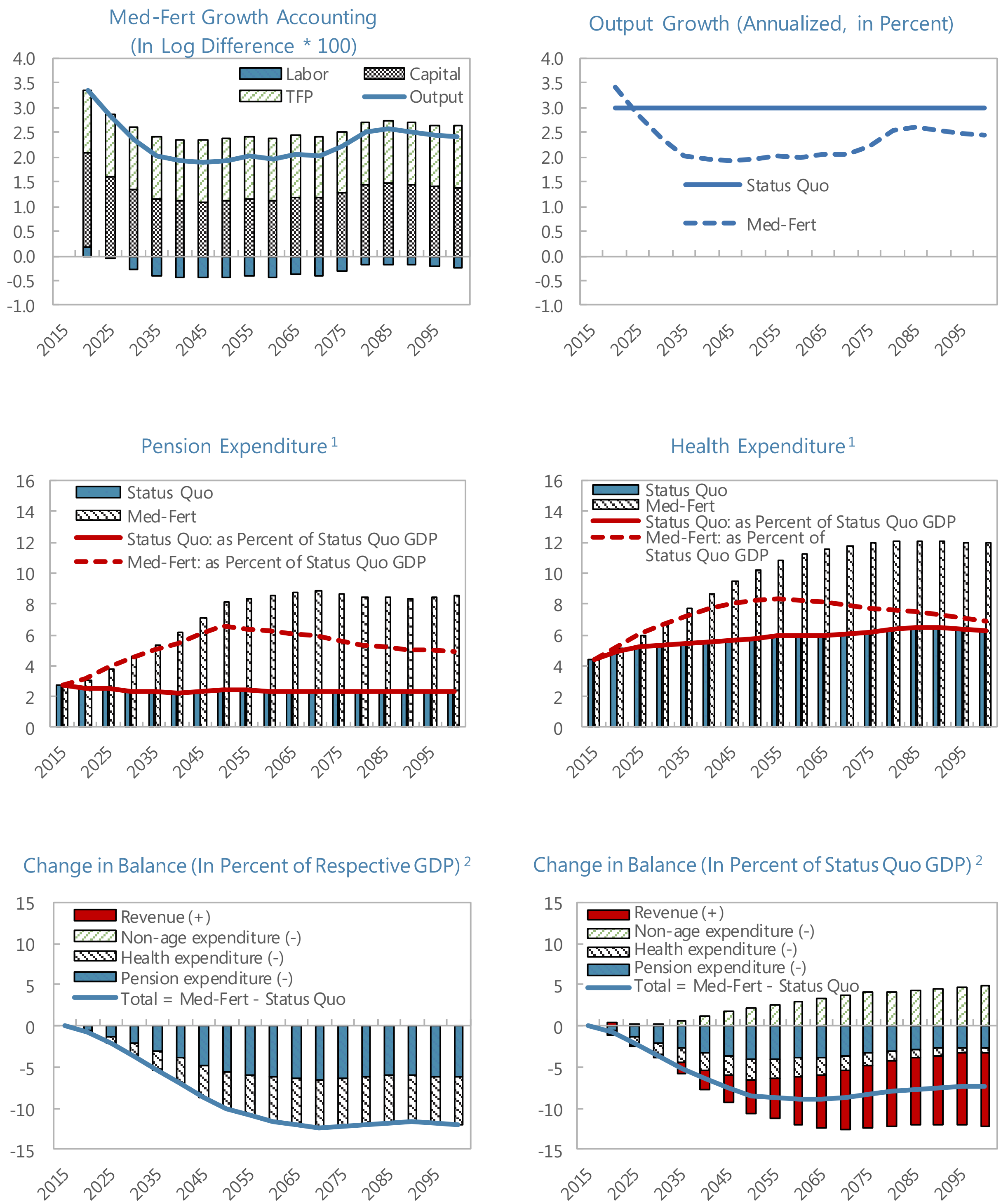
[17]The text chart displays the stock of age-related liabilities over the projection horizon as well as the constant flow of savings needed to reduce the stock as defined in equation (7). Both the stock (left axis) and the offsetting flow (right axis) are expressed in percent of current-year GDP (to have the same basis for both scenarios).

Figure 1. Korea: Demographics, 1950-2100



Sources: United Nations, and OECD.

Figure 2. Korea: Fiscal Impact of Demographics, 2015-2100

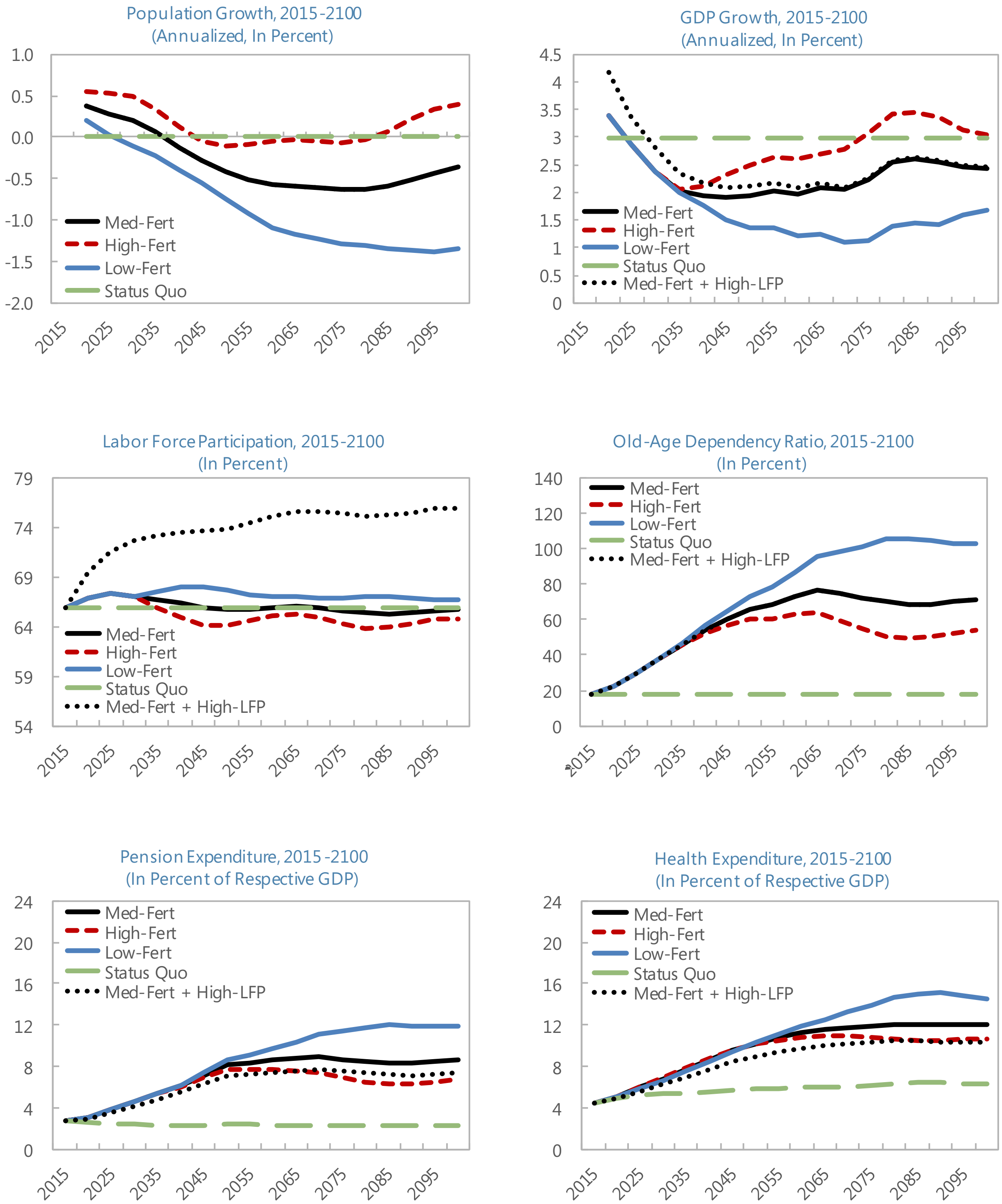


Sources: United Nations; OECD; and Fund staff calculations.

[1] The bars show expenditure in percent of own GDP. The lines normalize expenditure use GDP in the Status Quo scenario.

[2] Left: In percent of own GDP. Right: In percent of the GDP in the Status Quo Scenario.

Figure 3. Korea: Sensitivity Analysis, 2015-2100



Sources: United Nations; OECD; and Fund staff calculations.

Poland

This country case study provides an illustration of the flexibility of the framework and accompanying template to tailor scenarios to address pertinent policy questions.

Background

Poland's population stopped growing after 1995. The main cause was a drop in the fertility rate, one of the sharpest in Europe. In 2010–15, Poland was in the bottom quartile of the distribution in Europe in terms of fertility rates. Emigration, which was particularly high during 1985–2000, also contributed to the slowdown in population growth. At the same time, the old-age dependency ratio increased almost threefold during 1950–2015.

Under all UN demographic scenarios Poland's population is projected to shrink substantially over the next 85 years (Figure 4). Under the UN's medium-fertility scenario the population decline is expected to begin in 2017 and accelerate until the 2070s. In 2060, Poland's population is projected to be about 80 percent of its today's level, and in 2100 to be around 60 percent of that level.[18] The age structure of the population is expected to become much more evenly distributed, with the median age increasing from less than 40 years in 2015 to 51 years in 2100. As a result, the old-age dependency ratio is projected to almost triple, significantly exceeding that in most countries.[19]

Labor contribution to output growth over the last 25 years was on average zero and will become negative in the future. Except for a brief period between 2004 and 2008, the worsening of the labor force participation rates was the main reason behind the weak contribution of aggregate labor to output. The average growth, which during 1992–2014 was around 4 percent, is expected to slow in the future with the labor contribution to output growth being negative during the entire projection horizon. This assumes labor growth to be consistent with the projected demographic scenarios, total factor productivity growth in line with the historical average, and capital accumulation according to the balanced-growth condition. Under the medium-fertility scenario, trend growth is projected to drop to around 2 percent by 2050 and then rebound to close to 3 percent by 2100.

Assessing Fiscal Effects of Demographic Changes

Under current policies, replacement rates and the coverage ratio in Poland are projected to significantly decline. These projections reflect pension reforms of 1999, 2013 and 2014 (Krogulski and others, 2014). These reforms envisaged gradually moving from a defined-benefit formula, which was only partially linked to contributions, to a defined-contribution formula, which fully links the size of the benefit to the size of contributions. As a result of the benefit formula change, replacement rates, which currently are estimated at 53 percent, could drop by about 25 percentage points by 2060 (EC, 2015). Moreover, the 2012 reform gradually increases the retirement age to 67 years for both men and women (from 65 for men and from 60 for women), contributing to the lower share of pensioners in the total population above 65.

We estimate fiscal effects of two pension-specific policy questions (Figure 5). Back-of-the-envelope calculations show that maintaining the current level of the replacement rate would increase pension expenditure by nearly 8½ percentage points of GDP by the end of the projection period (2060). Alternatively, under the scenario where the replacement rate is allowed to decline but not to below 40 percent, additional pension spending would amount to 4½ percent of GDP by 2060. Another simulation scenario, which involves reversing the current policy of the retirement age and returning it to 65 years for men and 60 years for women, would increase pension spending to 12½ percent of GDP by 2050, 2¼ percentage points of GDP higher than under the current policies.

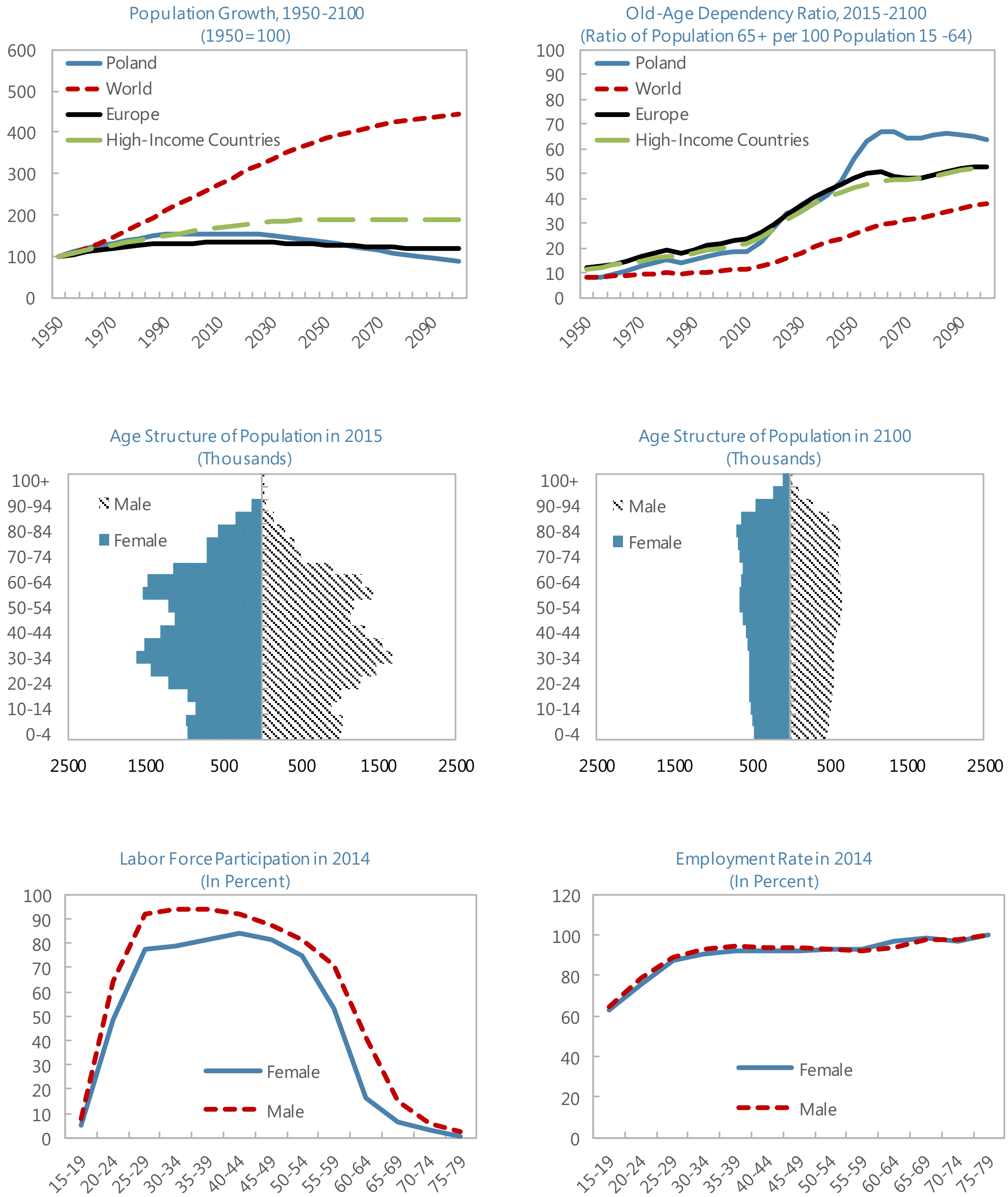
Policy Implications

The scale of fiscal challenges posed by the prospective demographic changes requires action from country authorities. Policymakers in countries with unfavorable demographics should recognize the severity of the problem and the urgency to start planning a response. Although fiscal challenges of the ongoing demographic transition will be felt gradually over many years, postponing policy action now could result in much larger required policy adjustments down the line. Therefore, policymakers should start designing a mix of policy reforms to counteract the effects of demographic changes. Acting early would also permit political

[18]According to Eurostat population projections (EC, 2015), the pace of population decline in Poland will be somewhat smaller than under the UN's medium-fertility scenario and by 2060 its population will be 86 percent of today's level.

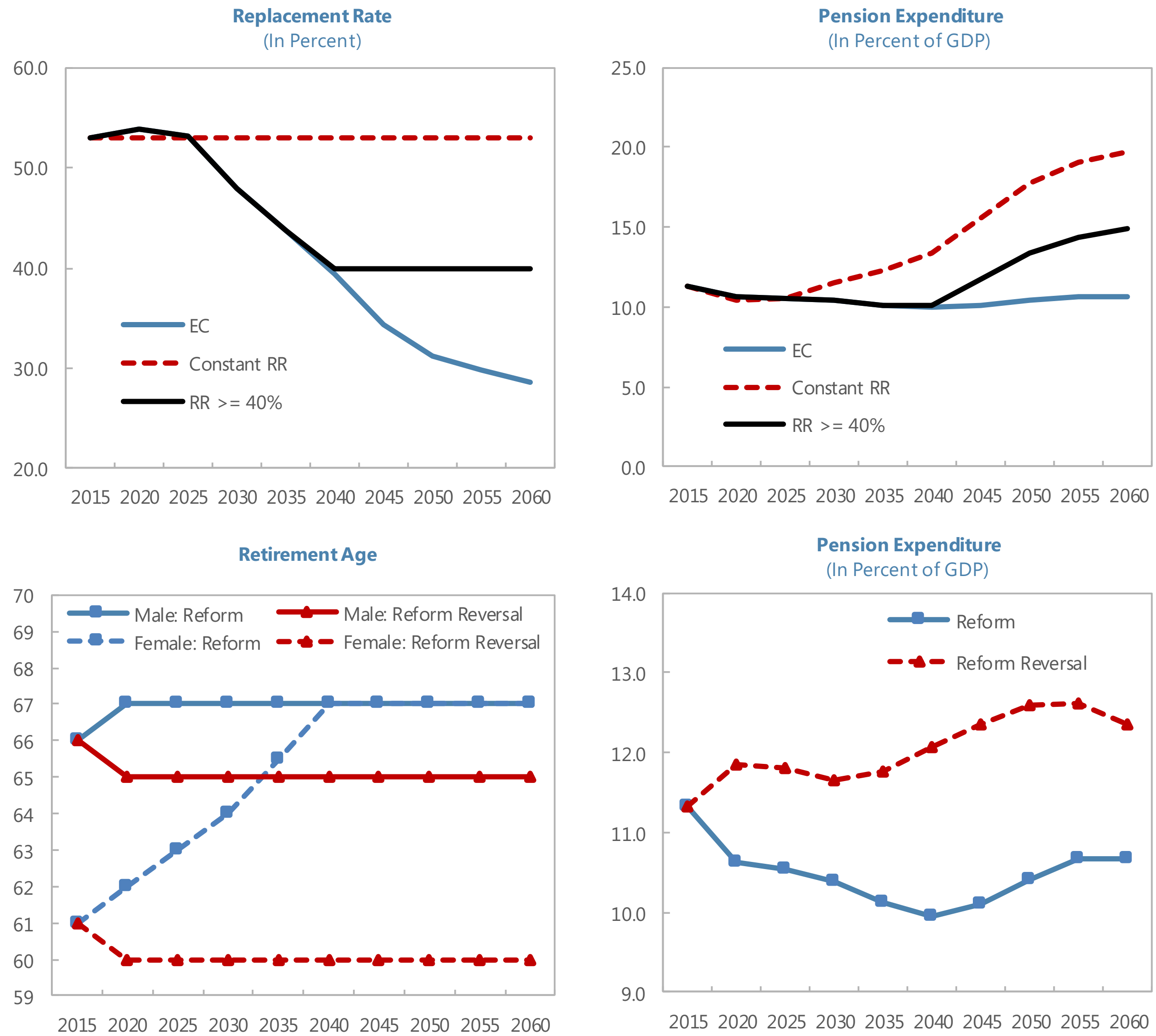
[19]The old-age dependency ratio is expected to have an explosive path in the low-fertility scenario.

Figure 4. Poland: Demographics, 1950-2100



Sources: United Nations, and OECD.

Figure 5. Poland: Pension Projection, 2015 -2060



Source: IMF staff calculations.

consensus to be built around these reforms, and phase them in to allow people to adjust their behavior.

A policy package to address demographic change should contain action on multiple fronts. The package should include policies that aim to boost labor supply and productivity, for example, by encouraging labor market participation. Structural reforms in the areas of health care and education would also help boost productivity and reduce costs. At the same time, reforms of public pension systems could play a central role. On the one hand, they could ease the burden on public finances. On the other hand, they could increase labor force participation rates of older age groups. In this context, formulating retirement age policies, taking into account the concept of "prospective age," would help achieve gradual adjustment in the retirement age and increase intergenerational fairness (Sanderson and Scherbov, 2008).[20] Reforms should also target fiscal balances more generally to reduce debt levels ahead of expected aging.

[20]In contrast to normal (chronological) age, prospective age measures remaining life expectancy in a reference year.

Annex 1. Practical Tips for Using the Template

Country-specific demographic scenarios. In the template, worksheet "Basic info", specify the country name, and the baseline and the benchmark population projection scenarios. The candidates for the baseline and benchmark population scenarios are restricted to eight scenarios prepared by the UN (discussed in Box 3) plus one hypothetical scenario, which fixes the population structure in the current year (2015) until the end of the projection period. See Box 3 for other parameters that could be changed.

Projections under the specified benchmark and baseline scenarios. These projections are performed in the worksheets "Demographic_Benchmark" and "Demographic_Baseline," respectively. Populate the benchmark pension and health care spending projection. In the template, rates for labor market participation and employment for each age-gender cohort are estimated using their most recent historical realizations (last five-year average). The user can overwrite default labor market projections to experiment with different policy settings.

Standard presentation of the results on panels.

- Figure 1 briefly summarizes 5 key demographic trends.
- Figure 2 assesses the fiscal impact of demographics. The top chart shows the growth decomposition. The middle two charts plot projected pension and health care expenditures under the chosen scenarios. The bars show the evolution of pension and health care spending relative to the size of the economy (in percent of respective GDP), while lines normalize the age-related expenditure by the benchmark GDP. The bottom left chart shows the difference in the fiscal balance as a percentage of respective annual GDP (benchmark versus baseline). For example, –5 percent in this chart suggests that the fiscal deficit in the baseline scenario will be 5 percentage points higher than under the benchmark scenario. Following the same logic, the bottom right chart expresses the relevant revenue and expenditure items in percent of benchmark GDP, which enables visualizing the indirect impact of demographic change on revenue and non-age-related spending. Using the same numerical example, –5 percent shown in this chart indicates higher deficits under the baseline scenario relative to the benchmark scenario.
- Figure 3 displays the results of sensitivity analysis. For instance, it can be performed against the more pessimistic low-fertility scenario and the more optimistic high-fertility scenario. It also includes a policy-driven scenario where labor force participation rates are higher than under the baseline scenario (for example, on account of a shrinking gender gap).

Annex 2. Key Default and Alternate Assumptions Underpinning the Analysis

Indicators	Default	Alternative
Population projections by age and gender	UN medium-fertility variant scenario	- Seven other scenarios from UN population projections - EC aging working group projections (for EU countries - National authorities
Total factor productivity projections	Historical average	Available country-specific projections
Labor force participation projections	Average of the past five years	ILO projections
Employment rate projections	Average of the past five years	ILO projections
Long-term elasticity of revenue to GDP	One	Different from one depending on country-specific circumstance
Long-term elasticity of non-age-related expenditure to GDP	One	Different from one depending on country-specific circumstance
Capital depreciation rate	5.9 percent (following Nadiri and Prucha, 1993)	Any other country-specific estimate
Discount rate (long-term interest rate)	2.6 percent (following Giglio and others, 2015)	Real discount rates of 3–7 percent suggested by the U.S. Office of Budget and Management (2003) as part of the guidance to federal agencies for regulatory analysis
Per capita health spending of individuals older than 65 years relative to those younger than 65 years	3.5 (average for a group of OECD countries, following De la Maisonneuve and Martins, 2013)	Country-specific estimates, if available

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