GROUP OF TWENTY

MACROECONOMICS OF AGING AND POLICY IMPLICATIONS

Prepared by Staff of the

INTERNATIONAL MONETARY FUND*

*Does not necessarily reflect the views of the IMF Executive Board.

EXECUTIVE SUMMARY

As a group, the G-20 countries are in the midst of stark demographic change. Steady declines in fertility rates have led to a faster reduction in the rate of growth of the working-age population (15-64 years old) relative to the overall population. In combination with rising longevity, this development has pushed up old-age dependency ratios (65+ year-olds as a share of the working age population. Migration has provided some offset to these changes in a few countries. Although the speed of these developments varies, under current policies, most projections suggest that these trends are set to accelerate in all G-20 countries.

Population aging can have significant macroeconomic implications. For those countries where fewer workers are available and labor force participation rates drop, economic output is bound to fall. However, the size of the decline depends, among other things, on how households and firms react to the changing demographic landscape. Labor productivity may fall due to a decline in older workers' physical and cognitive abilities, but the prospect of a declining labor force could also induce firms to invest in new, productivity-enhancing, technologies. Aging would also exert pressure on public finances as outlays for pensions and health care increase. The behavior of saving and investment will also have implications for the equilibrium real interest rate, with knock-on effects on monetary policy and the financial system. The differing pressure on capital-labor ratios and resulting effects on factor prices and production could generate cross-country spillovers for capital and labor, potentially mitigating some of the negative effects of aging. The objective of this note is to lay out the various macroeconomic implications of aging in a comprehensive manner to foster a better understanding of their interconnections.

Policymakers can deploy a set of policies to address the challenges posed by aging, with an emphasis on raising labor market participation and productivity. Labor market reforms to increase participation by older workers and women can directly counter the decline in the workforce. Policies to increase competition and innovation can raise productivity, while greater economic integration across countries could increase technology diffusion. Governments would need to address the fiscal challenges stemming from aging by adjusting fiscal policy and reforming pension systems and healthcare sectors. They would also need to properly calibrate monetary policy to reflect aging-induced interest rate developments. Finally, as the financial industry adapts to a new demographic landscape and to the demands of an aging population, regulatory and supervisory coverage should be updated while keeping an eye on financial stability.

Global risk-sharing and international cooperation can play a key role in mitigating some of the negative macroeconomic effects from aging. International capital flows can help alleviate domestic pressures generated by aging given their asynchronous nature. Furthermore, well-managed migration could relieve aging-related spending pressures and give countries time to implement further reforms. Given the international dimensions of the aging challenge, G-20 countries would benefit from sharing experiences and best practices, maximizing positive spillovers by strengthening multilateral frameworks (e.g., for trade, investment, and the protection of intellectual property rights), and enhancing coordination, including around freer movements of capital and labor.

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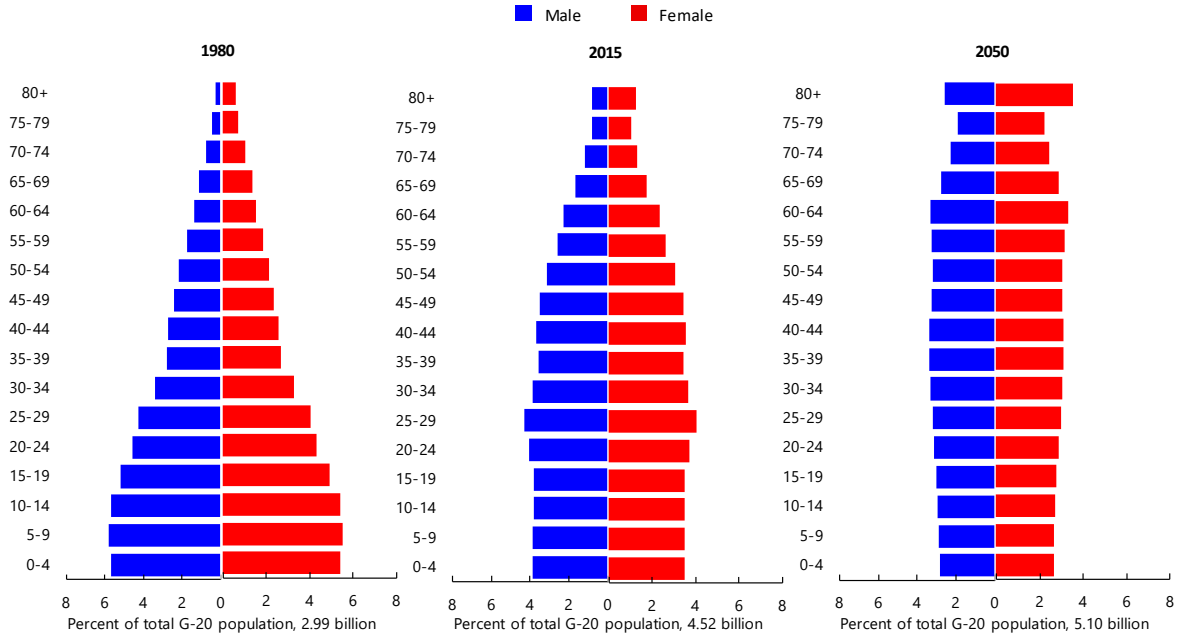
INTRODUCTION

1. As a group, the G-20 countries are in the midst of stark demographic change. The rate of population growth has been falling since the 1970s. The rate of growth of the working age population (15-64 years old) has been declining since the 1980s, and most recently it has done so at a faster pace than the overall population (Figures 1 and 2). The dependency ratio—defined as the ratio of people 65 and older to those between 15 and 64—has been rising, as the ranks of older people spending more years in retirement has grown relative to the working-age population. These developments are driven by declining fertility rates and increasing longevity, with immigration providing some offset in a number of countries.[1]

Figure 1. G-20: Population Distribution by Age Groups (*percent of total population*)



Sources: United Nations, Department of Economic and Social Affairs, Population Division (2017); and IMF staff calculations.

2. The speed of aging varies widely across G-20 countries. At nearly 43 percent in 2015, Japan has the highest old-age dependency ratio among G-20 economies, compared to 26 percent in other advanced G-20 countries and 11 percent in emerging G-20 economies. By 2050, under unchanged policies, old-age dependency ratios are projected to rise to 49 and 30 percent in advanced and emerging G-20 economies, respectively, and to even higher levels in some countries such as for example, 66 percent in Italy and 71 percent in Japan.

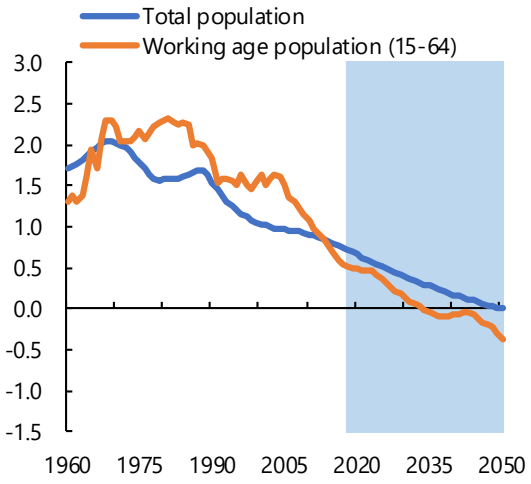
[1] See Appendix I for additional details.

3. The ongoing aging process will have significant macroeconomic implications, and several intertwined factors would be at work. As increasingly fewer workers are available and the population shrinks, output is bound to fall, while a rising dependency ratio implies a reduction in output per capita. However, the magnitude of these effects depends, among other things, on how households and firms respond. For example, while investment would generally decline given the reduction in aggregate output and the lower labor-capital ratio, the availability of new technologies may make investment in automation more attractive, which could raise productivity. This, in turn, could have knock-on effects on per capita income levels, household saving behavior, investment and interest rates.

4. Aging will exert pressure on public finances. IMF analysis suggests that between now and 2050, absent policy changes and reforms, outlays for pension and health care could increase by around 7 and 6 percentage points of GDP in advanced and emerging G-20 countries respectively (Figure 3). Such increases in spending could lead to unsustainable public debts, require sharp cuts in other public spending, or necessitate large tax increases that could stymie economic growth.

Figure 2. G-20 Population Growth [1/]

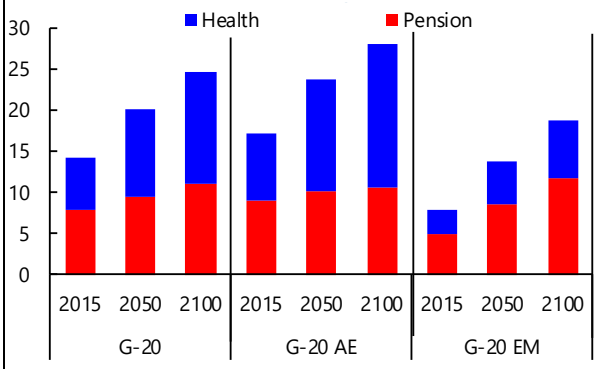
(Percent)



Sources: United Nations (2017); and IMF staff calculations.
1/ Area shaded in blue is based on projections.

Figure 3. Daunting Costs on Age-Related Spending

(Percent of GDP, nominal GDP weighted)



Sources: United Nation (2017); and IMF staff calculations.
Note: Age-related spending is composed of public expenditures for pensions and health.

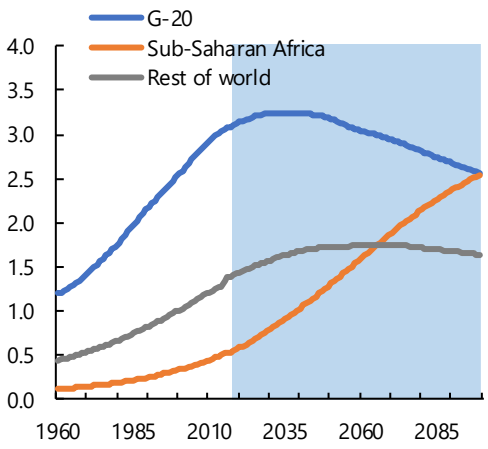
5. Aging-induced changes in savings and investment decisions could have implications for monetary policy and the financial system. As aging impacts savings—both public and private—and investment, interest rates may adjust to secure an equilibrium. If, as a consequence, interest rates were to drop, this could pose operational challenges for central banks in a low-inflation environment, making encounters with the zero lower bound and its associated challenges more frequent. The demand and supply of financial services is also likely to change with aging, while financial stability could come under threat as banks and the financial system move away from traditional business lines, and low expected returns encourage reach for yield abroad.

6. The asynchronicity of the aging process across countries could be a source of cross-border effects through capital and labor movements. Capital flows could be directed from older to younger societies, while labor flows could move in the opposite direction.

- Consistent with the life-cycle hypothesis, countries aging faster than the world average could initially experience rising, later possibly falling, current account balances driven by the aging-induced dynamics of their saving-investment balances. At the same time, countries with growing populations would experience current account deficits mirroring their relatively large investment needs.

- Furthermore, aging societies where the labor force is shrinking would see their wages increase relative to societies with an abundant labor force and would thereby create incentives for labor to migrate (Figure 4).

Figure 4. World: Working Age Population, age 15-64 ***(billions of persons)***



Sources: United Nations (2017); and IMF staff calculations.

7. The macroeconomic and fiscal effects of aging pose a number of important challenges for economic policy which can be addressed through a menu of country-specific policies. Governments can implement measures to increase labor force participation, while also undertaking reforms to raise productivity. They will also need to implement pension and healthcare reforms as well as adjust fiscal policy. Knock-on effects on interest rates stemming from saving-investment behavior will require central banks to carefully monitor the behavior of equilibrium interest rates and recalibrate monetary policy as needed, while the financial services industry will need to adjust its business model. Finally, allowing capital and labor flows to move across countries could help mitigate some of the domestic economic pressures generated by aging.

8. The various macroeconomic channels of aging will interact in general equilibrium. This is the case, as just discussed, for the interplay of saving and investment, which drives interest rates and determines aggregate demand. At the same time, aging affects the size of the active workforce and, more generally, supply, subject to the path of investment and productivity. In addition, economic policy plays an important role—either directly though changes in public saving, or indirectly by shaping the incentives of households to save or supply work and of firms to invest and innovate. For example, the degree to which old-age labor force participation will rise will depend on the characteristics of the pension system. Labor force participation, in turn, will matter strongly for public and private saving and investment and thereby for the real rate of interest. Section III.D will provide empirical estimates of the aggregate effects of these forces.

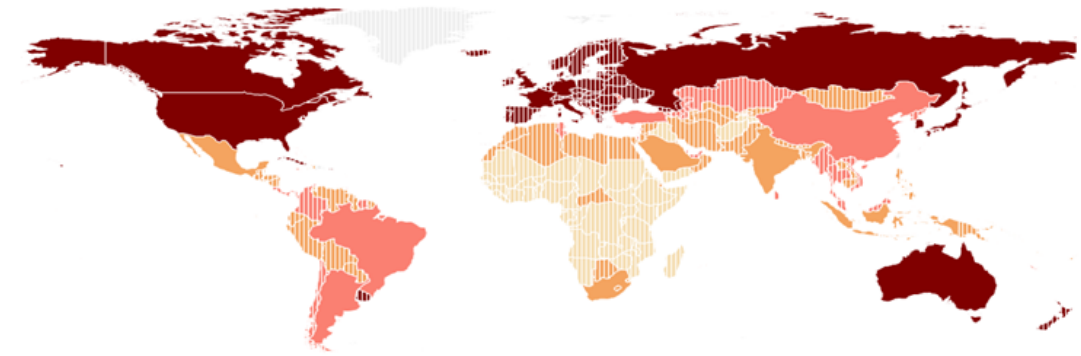
DEMOGRAPHIC TRENDS IN THE G-20

9. G-20 countries are aging but at different speeds. To discuss the aging developments with some granularity, G-20 countries can be broadly grouped into stages of demographic transition according to their rates of fertility and mortality (Figure 5).[2] Specifically:

- **Late stage demographic transition group:** Most advanced and some emerging G-20 economies are further ahead in their demographic transition, with the aging process well under way and the working age population about to decline or already declining (Australia, Canada, France, Germany, Italy, Japan, Korea, Russia, Spain, UK, and United States).
- **Advanced stage demographic transition group:** Other emerging G-20 countries (Argentina, Brazil, China, and Turkey) have already enjoyed the bonus of a demographic dividend—a period during which the working age population expands relative to the young and the old. Intuitively, more workers make it easier to take care of a relatively smaller pool of elderly people through intergenerational transfers (pensions or intra-family transfers). This bonus has now ended in many countries in this group and will end very soon for the rest.
- **Early stage demographic transition group:** In such countries (India, Indonesia, Mexico, Saudi Arabia, and South Africa), fertility rates are declining but remain relatively high with the share of working age population expected to peak in the coming decades.

Globally, a number of non-G-20 countries especially in Sub-Saharan Africa are in the prior transition demographic stage in which both fertility and mortality rates are high.

Figure 5. Demographic Transitions across Countries

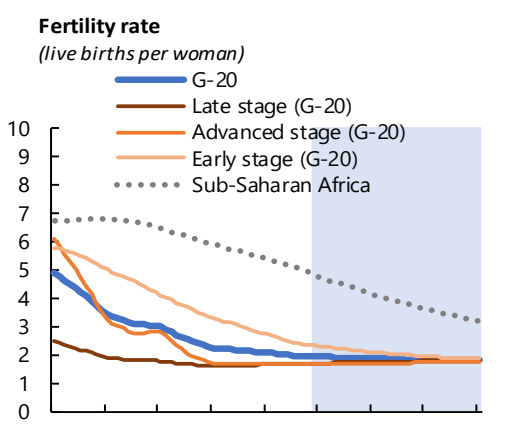


Source: Amaglobeli et al (2019).

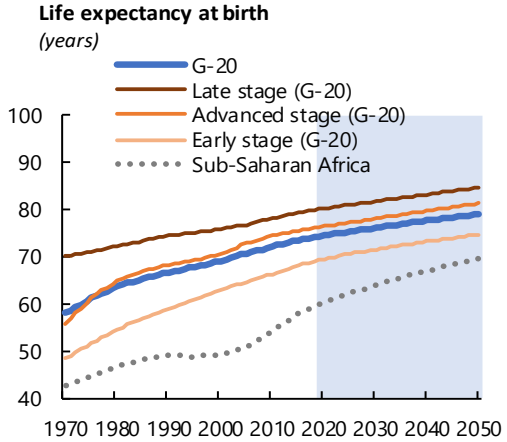
[2] See Amaglobeli and others (2019).

10. Projections point to rapidly rising old-age dependency ratios. Current data suggest that for all the advanced and a few emerging G-20 countries (Brazil, China, and Russia), fertility rates are below the replacement rate (i.e., the fertility rate at which a population exactly replaces itself from one generation to the next) and are steadily declining (Figure 6). By 2050, all G-20 economies are expected to have fertility below replacement which would imply smaller cohorts joining the labor force. At the same time, life expectancy is projected to increase by 5 years from 74 to 79 years. The combination of these developments would lead to large increases in old-age dependency ratios. While today Japan is the only G-20 country with an old-age dependency ratio over 40 percent (11 countries are below 20 percent), by 2050 nine G-20 countries will exceed this ratio by wide margins.

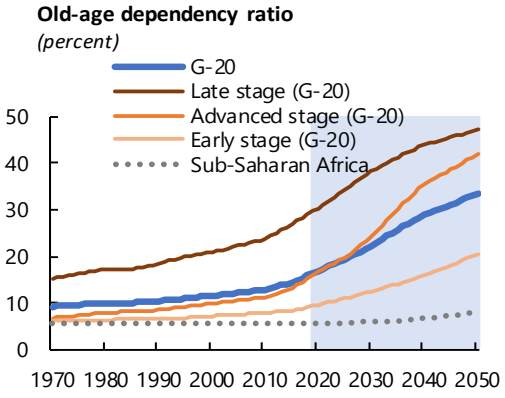
Figure 6. Demographics Trend



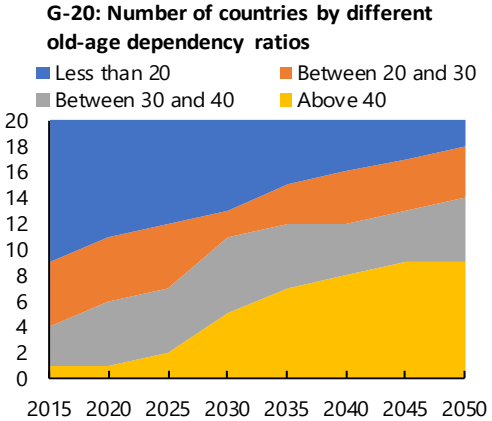
Source: United Nations (2017).
Note: Population weights are used to sum across country groups.



Source: United Nations (2017).
Note: Population weights are used to sum across country groups.



Source: United Nations (2017).
Note: The old-age dependency ratio is the number of people ages 65 and older divided by the population ages 15 to 64. Population weights are used to sum across country groups.



Source: United Nations (2017).
Note: The old-age dependency ratio is the number of people ages 65 and older divided by the population ages 15 to 64.

Note: late transition: AUS, CAN, DEU, ESP, FRA, GBR, ITA, JPN, KOR, USA, and RUS; advanced transition: ARG, BRA, TUR, and CHN; early transition: IDN, IND, MEX, ZAF, and SAU.

11. Migration will also affect demographic change. From a demographic perspective, migration is a much smaller component of population change than births and deaths in most countries. However, in some countries the contribution of international migration to the change in population size or distribution is quite significant, in particular for countries and regions where the number of migrants who depart or arrive, including refugees, is relatively large compared to the size of the sending or receiving population. Current demographic characteristics suggest a world roughly split between younger (primarily non-G-20 countries) and older (many of which G-20) societies (Figure 5) and points to possible migration flows in the coming decades. In countries with young and growing working age populations, labor would be in ample supply compared to countries with older and shrinking working-age populations. This would push up relative wages in the latter and create incentives for migration. To the extent that labor flows from countries with young populations to those with aging populations and is employed, migration could help smooth asynchronous demographic patterns across countries.

12. Some caution is required with demographic statistics as projection uncertainty is high. This note is based on the UN Population Division's projections of the medium-fertility variant which assumes a decline in fertility in countries where large families are still prevalent and a slight increase in fertility in some countries with fewer than two children per woman on average (see Appendix I). Survival prospects are also projected to improve in all countries. However, although the aging trend of the current world population is known, long-term projections are strongly dependent on the underlying assumptions regarding fertility rates, life expectancy, and migration flows, all of which are uncertain. For example, in the past fertility and mortality have declined at a much faster pace than projected by institutions like the United Nations.

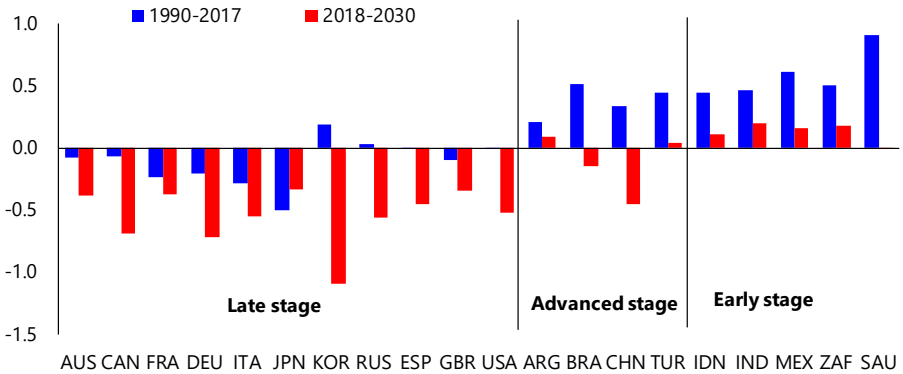
MACROECONOMIC IMPLICATIONS

A. Output

13. Holding all else constant, a rising dependency ratio can be a drag on *per capita* GDP growth.[3] Figure 7 illustrates the expected effect of rising old-age dependency ratios on per capita GDP growth for the G-20 economies between 2018 and 2030 along with the historical effect in the period 1990-2017. It suggests that, going forward, aging would exert downward pressure on GDP per capita growth by an average of about 0.4 percent, with the late stage economies experiencing the highest decline of about 0.5 percent. For most countries this implies that the headwinds from aging on GDP per capita would be increasing, with only Japan experiencing a slower decline than in the past given its advanced aging process. These results suggest labor productivity would need to rise by similar orders of magnitude to offset the labor-force decline. This compares to average labor productivity growth rates of 1.5 percent and 4.2 percent between 1990 and 2017 for G-20 AEs and EMs respectively.

[3] See, among others, Persson (1999), Bloom, Canning, and Malaney (2000), and Aiyar and Mody (2013) for the relationship between age structure and economic growth.

Figure 7. Average annual Contributions of the Change of the Share of the Working Age Population to GDP per Capita Growth [1/]



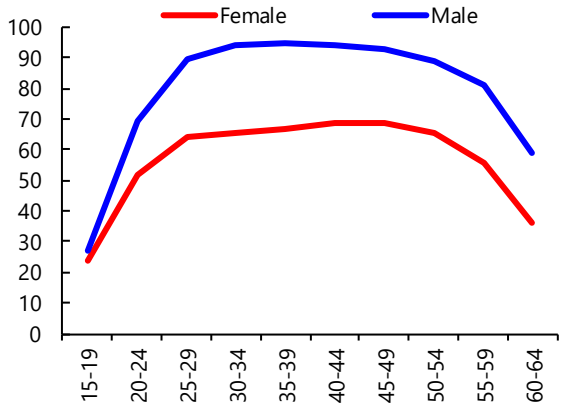
Sources: Feenstra et al. (2015); United Nations (2017); IMF, *World Economic Outlook* October 2018; and IMF staff calculations.

1/The figure shows the average annual contribution of the change of the share of the working age population to GDP per capita growth. The computation follows from a decomposition of GDP per capita, which can be written as (GDP/Population) =(GDP/Working age population)*(Working Age Population/Population).

14. Lower labor input and productivity could also cause a decline in *aggregate* potential output. A simple production function relating gross domestic product to the capital stock, a measure of productivity, and labor input illustrates how aging affects output through various channels (see also Box 1 for additional details):

- **Fewer workers overall**. In countries in the late stage demographic transition group, the fall in the working-age population directly reduces output as less labor input is available for production.
- **Lower participation rates**. The composition of the workforce shifts from relatively young to relatively old workers. As the elderly tend to participate in the labor force at much lower rates, this will further reduce the available pool of workers (Figure 8).[4]
- **Productivity effects**. Some research finds that older workers are less productive than younger workers.[5] A rise in the share of older workers could then imply a decline in aggregate productivity and a further reduction in output. This could be the case if the accumulation of experience does not make up for the

Figure 8. G-20 Labor Force Participation Rate, 2015 ***(Percent; per age chart)***



Sources: United Nations (2017); ILO modelled estimates (2017); and IMF staff estimates.

[4] See also Amaglobeli and Shi (2016).

[5] See Murphy and Welch (1990), Lindh and Malmberg (1999), Feyrer (2007), Liu and Westelius (2016), Aksoy et al. (2016), Aiyar, Ebeke and Shao (2016) and Maestas et al. (2016).

depreciation of knowledge and the loss in the physical or mental capabilities of older workers. Furthermore, entrepreneurial activity tends to be lower among older workers, which could imply a reduction in productivity growth through innovation.[6]

15. Immigration, secular changes in labor force participation, and improvements in health and education can mitigate the growth trajectory. While the decline of the native working-age population in late stage demographic transition countries is predetermined by fertility decades before, immigration can reduce the drag on the overall working age population. Furthermore, labor force participation rates have been rising strongly among older workers since about the turn of the century, driven by policies that aim to encourage later retirement but also improvements in health and education.[7] Participation rates among women, while still below those of men, have risen strongly too.[8] Finally, improvements in health and education have been found to contribute to strongly increasing productivity among older workers.[9]

16. The impact of aging on per capita and potential output will be further affected by firms' response to the decline in the workforce. While aging will typically imply lower demand for business structures, the effect on investment into machinery and equipment is less clear. The latter is important, however, as high investment holds the potential to raise labor productivity. Under typical circumstances, a declining labor force results in a decline in the marginal return on capital. This lowers firms' incentives to invest, so that over time the capital stock shrinks. At the aggregate level, the capital stock declines given a shrinking economy with a smaller population. However, this assumes a strong degree of complementarity between capital and labor: fewer workers need fewer machines and equipment to perform their production tasks. But certain technologies are a substitute rather than a complement to human labor—including, for example, new technologies such as artificial intelligence and automation or robots, which, over time, may be able to replace humans in an increasing number of specific tasks. Firms facing labor shortages and rising wages due to a shrinking workforce may choose to use robots in production rather than scale down or relocate to economies with larger and younger workforces (see Box 2 for additional details).[10] Under such a scenario, both output per worker and output per capita may rise, and the economy could become richer than before in per capita terms. However, a precondition for investment in new technologies of this type is the availability of financing for firms which, in turn, depends on saving decisions. As such decisions are strongly affected by aging, they are discussed in detail in the next section.

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[6] See Jones (2010) and Liang et al. (2018).

[7] See Prettner et al. (2013) and Burtless (2013). Milligan and Wise (2015) discuss the increased health of older workers and potential for increased participation.

[8] Ostry et al. (2018) find that increasing female employment can yield greater output gains than an equivalent increase in male employment as driven by new skills brought by women and sectoral reallocations.

[9] While much of the literature reports a negative impact of aging on productivity, some evidence from the US points to rising relative hourly wages among older workers. Moreover, there is some evidence of increasing GDP per capita with aging populations since 1990 in a large sample of countries. See Burtless (2013) and Acemoglu and Restrepo (2017).

[10] See Acemoglu and Restrepo (2017) and He and Piazza (2018).

B. Saving

17. Aging affects saving, with important repercussions for interest rates. As discussed, at the national level, aggregate saving is determined by the behavior of private and public saving, both of which are affected by population aging. Moreover, as saving rates and investment jointly determine interest rates, their interaction has implications for monetary policy, the financial system and current accounts.

18. Private saving is likely to decrease for economies at the late stage of demographic transition and increase for those at earlier stages. These effects are driven by the impact of aging on the saving incentives of individuals as well as the composition of age cohorts: [11]

- A decline in fertility increases saving by the working-age population as childcare spending is reduced, and workers put aside part of their increased resources for future consumption. An increase in life expectancy and the expected future old-age dependency ratio also raises private saving at all ages to finance old-age consumption. These effects tend to dominate in earlier stages of demographic transition and contribute to rising private saving.
- At the same time, aging changes the composition of age cohorts with differing saving rates. Saving rates tend to vary over the life cycle, rising in early stages of life and declining as people age. On the one hand, aging economies may experience a period with a rising share of "prime savers"- workers between 45 and 64 who tend to have the highest saving rates. This would increase overall private saving. On the other hand, a rising old-age dependency ratio raises the share of dis-savers (retirees) relative to savers (the working age population) and tends to depress aggregate private saving. This effect is particularly strong for countries in the late stage of demographic transition with an already higher share of old-age population, hence lowering aggregate private saving.

19. Public finances are likely to come under pressure. Under a Defined Benefit (DB) pension system financed by a Pay-As-You-Go (PAYG) basis, the most common public pension arrangement worldwide, total pension spending will increase with a rise in the old-age population share, while pension system revenues will decline as the working-age population shrinks. In addition, as per capita health spending tends to rise with age, public health spending would rise as well.[12] Overall, age-related public spending is projected to increase by 6 percent of GDP by 2050 in the G-20. Under unchanged policies, these increases would be driven mainly by healthcare costs, while pension spending would remain relatively contained owing to past pension reforms, especially in many advanced economies. Pension spending in EMs will experience a much steeper rise, albeit from lower starting levels. Absent policy changes, rising spending needs will worsen the fiscal balance and hence depress public saving.

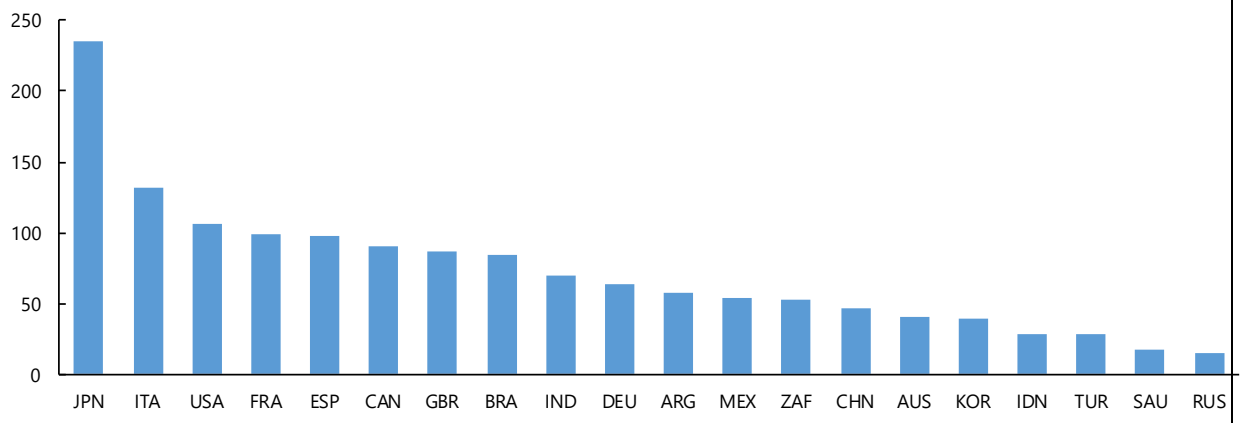
20. The sustainability of public debt could come into question. First, worsening fiscal conditions would push public debt to even higher levels and increase vulnerabilities, particularly for countries where debt levels are already elevated (Figure 9). Second, lower economic growth would

[11] See, for example, Bloom et al. (2013), De Nardi (2010), Backus et al. (2014), and Amaglobeli et al (2019).

[12] See Amaglobeli and Shi (2016).

negatively affect public debt dynamics. In fact, unless changes in the real interest rate were to fully offset the slowdown in GDP growth—which seems unlikely (see Section III.D)—changes in the interest-growth differential could make it harder for countries to reduce the public debt-to-GDP ratio over time. Unfavorable debt dynamics would further squeeze fiscal space, leaving countries less well equipped to deal with adverse macroeconomic shocks.

Figure 9. General Government Debt, 2017 ***(Percent of GDP)***



Source: IMF Global Debt Database.

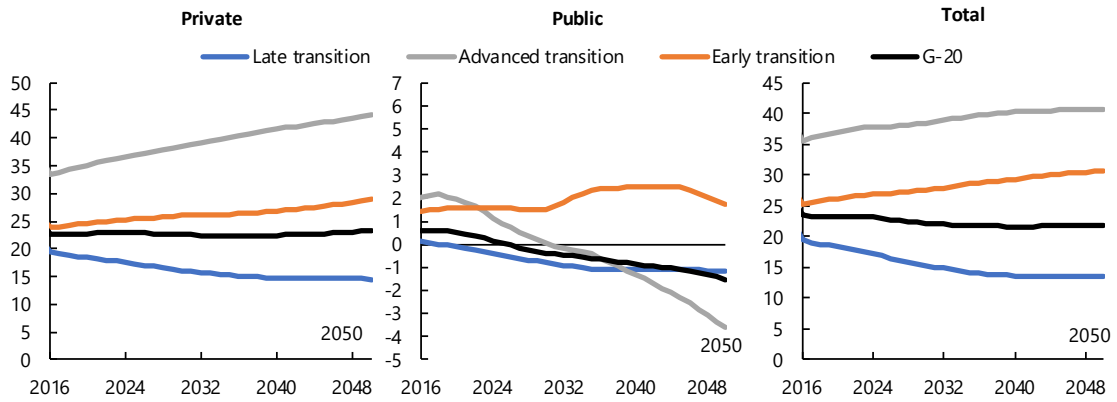
21. How private and public saving interact depends on a country's institutional setup—in particular the generosity of its public pension system and the presence of dedicated pension saving accounts.[13] Most countries rely on defined benefit (DB) pension schemes, under which benefits depend on the number of years of contributions and the individual's earning history, typically complemented by a means-tested basic pension. Some countries have defined contribution (DC) pension systems based on individual accounts, which often coexist with the DB scheme. Pension systems also differ in the extent to which liabilities are pre-funded. The presence of DC schemes incentivizes saving, as confirmed by empirical evidence in Amaglobeli et. al. (2019). Most DB schemes are financed on a PAYG basis, in which general revenues or specific contributions from current workers and employers fund the benefits of current retirees. In contrast, pension benefits in most DC schemes depend on the value of accumulated assets over the individual's working life. The generosity of a pension system captures two aspects, the benefit ratio and coverage. The benefit ratio is defined as the average pension divided by the average pre-retirement earning, and coverage is defined as the number of pensioners as a share of the population over 65 years of age. Since private saving and public pensions are substitutes in the provision of retirement income, the more generous the public pension benefits, the lower the amount of private saving an individual would need to put aside.

[13] See Amaglobeli et. al (2019) for saving projections featuring these pension system characteristics and Chai and Kim (2018) for a theoretical model underpinning them.

22. National saving in countries with relatively generous pension systems are likely to experience a sharper decline compared to countries with less generous pension systems. The presence of a PAYG public pension system, which uses employer and employee contributions to pay for current benefits to retirees, tends to reduce private saving incentives, and this effect is more pronounced when the public pension system is more generous. The private saving rate is also found to be higher in countries combining a DC pension with a PAYG system.[14] Uncertainty over the future sustainability of the pension system or expectation of future pension cuts due to high generosity or fast aging could encourage further precautionary saving.[15]

23. Overall, aggregate G-20 saving is likely to slightly decline with aging, although there is significant heterogeneity across demographic transition stages (Figure 10).[16] Recent IMF work which takes into account projected demographic changes and pension reforms already under implementation suggests that in the coming decades aggregate saving could decline for late stage demographic transition countries and increase for countries at earlier stages of demographic transition.

Figure 10. G-20 Savings ***(Percent of GDP; Nominal GDP Weighted)***



Source: Amaglobeli et. al (2019); and IMF staff estimates.
Note: The advanced transition group includes China which has a much higher level of private savings relative to the rest of the countries in its demographic group.

- All advanced G-20 countries belong to the late demographic transition phase, and their aggregate saving is projected to decline from around 20 percent of GDP in 2016 to around 15 percent in about 20 years from now. The decline in public saving would be partially mitigated by pension reforms that will take effect during the projection period. While public saving would decline for countries in all demographic transition stages, private saving would only decrease in late stage demographic transition countries, largely driven by the increase in the ratio of retired dis-savers to working-age savers.

[14] See Amaglobeli et. al. (2019).

[15] See Kitao (2018) and Dao and Jones (2018).

[16] See Amaglobeli at al. (2019) and Box 3 for a summary of the methodology and findings.

- For G-20 countries at an advanced or early stage of demographic transition, national saving will continue to rise as the working-age population saves more for a longer life in retirement, and the increase of their collective private saving outweighs both the dissaving of retirees and the decline of public saving (see Box 3 for additional details on this analysis). The decline in public saving is particularly pronounced for this group, due to a rapid rise in projected old-age dependency ratio and the lack of adequate pension reforms relative to the countries in the late stage of demographic transition.

C. Real Interest Rate and Implications for Monetary Policy and Financial System

24. In past decades, aging has contributed to lower real rates of interest. The equilibrium real rate of interest brings in balance the supply and demand for saving—both at the country and, through international movements of capital and current accounts, at the global level. While difficult to estimate and magnitudes vary widely across studies, recent research finds that aging among the main drivers of the decline in the real interest rate observed in many countries in recent years.[17] This decline suggests that aging increased the supply of savings relative to the demand for savings (i.e. investment).

25. There is less certainty about the impact of aging on real interest rates going forward. Many studies conclude that the (equilibrium) real interest rates are unlikely to increase back to historical levels any time soon given projected demographic changes. However, various forces that counteract one another are at play. On the one hand, as emerging economies experience similar demographic changes to those of advanced economies but with a delay, their response can be expected to exert the same downward pressure on global real interest rates through higher savings.[18] Furthermore, increases in longevity and expectations of even higher old-age dependency ratios may induce working-age households to further increase saving, while retirees may dis-save at a slower pace.[19] This would add continued downward pressure on real interest rates. On the other hand, the projected decline in aggregate saving for the G-20 economies due to retirees' dissaving would point towards higher interest rates, as would an increase in investment in robots or automation. The overall effect will depend on the relative magnitude of these forces.

26. Past experience with declines in the real interest rate points to constraints for monetary policy. Broadly, central banks set the real policy rate below the equilibrium real rate in order to boost economic activity towards potential output and guide inflation to its target level, while they set it above the equilibrium rate in order to tame inflation and cool down economic activity. The fall in the equilibrium real interest rate over the past decades created additional challenges for some central banks as it required them to lower their policy rates to avoid excessively contractionary or insufficiently expansionary monetary policy stances. In countries where the interest rate hit the zero lower bound,

[17] See, for example, Carvalho et al. (2016), Gagnon et al. (2016), Lisack et al. (2017), Barany et al. (2018), Jones (2018) and Eggertsson et al. (2019).

[18] See Barany et al. (2018).

[19] See Lisack et al. (2017).

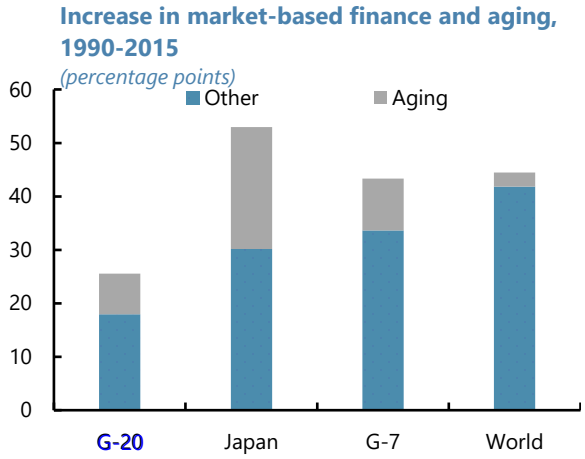
conventional monetary policy became constrained necessitating a recalibration of monetary policy, in particular the development and use of 'unconventional' tools whose impact is still being assessed. Furthermore, the lower bound has implications for inflation going forward.

27. The constraints for monetary policy could impact central banks' ability to steer inflation in line with their targets. At low levels of the equilibrium real rate, monetary policymakers could be facing an asymmetry: while it is always possible to raise the real policy rate to reduce aggregate demand and ensure an inflation target is met from above, it becomes more difficult to reduce the real policy rate to boost demand and lift inflation towards its goal from below. The latter is because the combination of a low real rate and low inflation can push nominal interest rates close to the zero lower bound, which means that conventional monetary policy instruments will need to be supported by unconventional monetary policy (such as forward guidance, negative interest rates, or asset purchases) and fiscal policy.

28. Moreover, the estimation of equilibrium real interest rates in real time remains a challenge. As the equilibrium real interest rate is unobservable, it needs to be estimated. However, as pointed out above, aging affects the real economy through many channels, rendering its link to the equilibrium real interest rate and its evolution highly uncertain. Hence, estimates of the equilibrium real interest rate are prone to errors, complicating real-time monetary policy decisions. The future path of the equilibrium real rate will thus remain a challenge for policymakers.

Figure 11. Effect of Aging on Financial Intermediation

About 40 percent of the increase in the size of market finance in Japan since 1990 can be explained by aging.



Source: Updated from IMF country report "*Japan : Financial Sector Assessment Program-Technical Note-Long Term Challenges for Financial Intermediation*" (2017b).

Note: The columns show the increase in market-based finance—stock market capitalization as a percent of bank credit to private sector—during 1990-2015 and the part of the increase that can be attributed to aging.

29. Aging seems to be associated with a smaller relative role of banks in financial intermediation. Recent IMF analysis finds that economies with an aging population tend to feature smaller term spreads (IMF 2017a). Smaller term spreads, in turn, are associated with less bank finance, which is consistent with other evidence on the negative effects of flat yield curves on bank profitability.[20] For example, the analysis suggests that the increase in the old-age dependency ratio observed in Japan between 1990 and 2015 could account for up to 40 percent

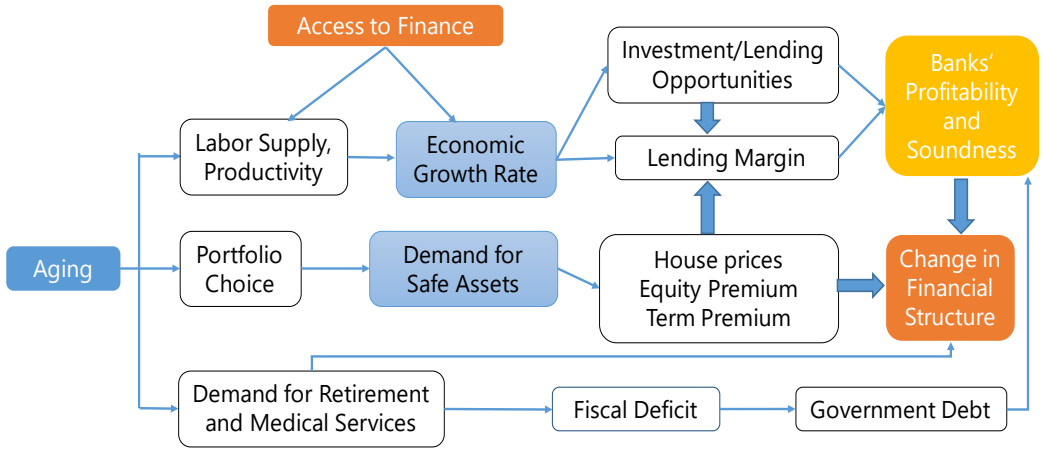
[20] IMF (2017b) uses a dataset of 38 advanced and emerging economies to study the effect of aging on the composition of financial systems around the world.

of the decline in the importance of bank finance observed during the same period. For the G7 and G20-averages the estimates are about 20 and 30 percent, and for the world it is 6 percent (Figure 11).

30. Aging could have a sizable impact on banks' business models. When young, households get education and housing loans from banks, which they repay as they get older. As populations age, banks will be used more for payment purposes and less for maturity transformation. With fewer young borrowers, traditional lending activities and loan-to-deposit ratios may decline, and banks may have to enter new activities and act more like non-banks. Indeed, IMF analysis of Japanese regional bank data shows that aging and shrinking populations tend to lead to smaller balance sheets and declining loan-to-deposit ratios (IMF 2017b). The evidence suggests that population aging has been an important driver of an ongoing shift in regional banks' business models, moving away from primarily lending-oriented banking towards a greater focus on securities investments and fee-generated sources of income. This is one of the various channels though which aging can affect the financial sector (Figure 12).

Figure 12. The Effect of Population Aging on the Financial Sector—A Schematic Approach

Aging can affect the stability and structure of the financial systems through its effects on economic growth, real interest rates, and risk premiums.



Source: IMF staff.

31. Through the effect on financial intermediation and the business models of financial institutions, population aging can have transitory implications for financial stability. Aging societies face heightened longevity risks—the risk of living longer than expected—and, in many jurisdictions, there is a lack of instruments to hedge this risk. Those exposed—DB pension plan sponsors, life insurance companies (through their annuity books), and households—could face financial difficulties in the event of a realization of this risk (IMF 2012). Also, as banks and the financial system move away from traditional maturity transformation into securities intermediation and other nonbank activities, there is a greater risk that their activities fall outside of existing regulatory and supervisory perimeters. Finally, low expected returns may encourage banks and other financial institutions to reach for yield abroad, giving rise to financial stability challenges in their home markets.

D. Aggregate Effects and International Implications

32. Asynchronous aging across countries affects current account dynamics, mitigating some of its detrimental effects. An increase in a country's savings-investment balance driven by aging implies changes to its current account balance and capital flows. For example, a larger drop in a country's fertility relative to the average for the rest of the world would tend to increase a country's relative saving and the current account position (assuming investment does not fully offset the change in savings). In contrast, a country aging more slowly or still experiencing a population and workforce expansion can expect its current account balance to decline. The resulting capital flows constitute a natural process of reallocation of resources to their most efficient use worldwide and thereby supporting global growth: countries aging faster, saving more, and sending capital abroad would benefit from the higher returns abroad, while countries aging more slowly and receiving capital would benefit from more resources for domestic production.[21]

33. Reflecting the likely aggregate impact of aging on the savings-investment balance, capital tends to flow out of countries at later stages of demographic transition and into those at earlier stages.

- The joint projected effects of demographic variables on the current account balances of G20 countries assuming they follow policies in line with economic fundamentals can be estimated empirically using existing IMF methodology.[22] These projections reflect the country-specific net effect of several demographic determinants. (Figure 13) For example, the interplay of rising life expectancy and future old age dependency ratios increases the current account balances for all advanced G-20 economies, while it decreases it for all emerging G-20 economies. Thus, the additional saving needed in advanced economies to meet expected rising consumption needs in the future due to rising longevity tend to increase their current accounts. The opposite holds for the current relative old-age dependency ratios which weigh on advanced economies' current accounts. In contrast, the relative share of prime savers—workers with the highest propensity to save—does not have a clear pattern across advanced and emerging economies.

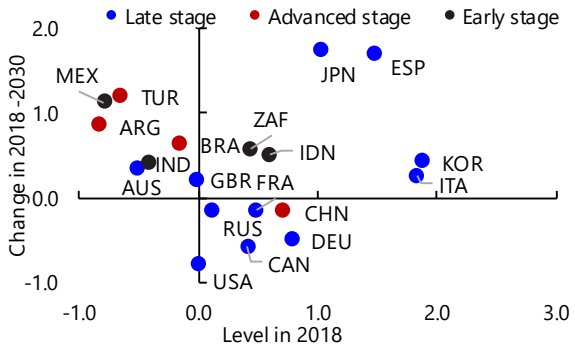
- The results suggest that, overall, capital flows from older to younger countries (Figure 14). These implied capital flows would thereby support global income convergence as late stage countries are predominantly richer than the younger economies. Given the partial nature of these estimates

[21] However, capital flows have distributional implications, with workers in capital-importing economies benefiting from a higher capital stock that raises wages, while domestic capital owners see their returns on the existing capital stock decline. The opposite effect would take place for capital-exporting economies. See Krueger and Ludwig (2007) and Fehr, Jokisch, and Kotlikoff (2013) for the distributional effects of aging-related capital flows and Engler and Wulff (2014) for a more general treatment of the distributional effects of capital flows between capital-rich and capital-poor economies.

[22] This exercise is based on the IMF's External Balance Assessment (EBA) methodology. The demographic variables employed are: (i) relative population growth rates; (ii) current old-age dependency ratios; (iii) relative share of "prime savers" (population aged 45-64 relative to the entire working age population); (iv) relative life expectancy at prime age; (v) interaction of the relative life expectancy at prime age with the future old-age dependency ratio. For additional details, see IMF (2018a). Demographic variables come from the United Nations.

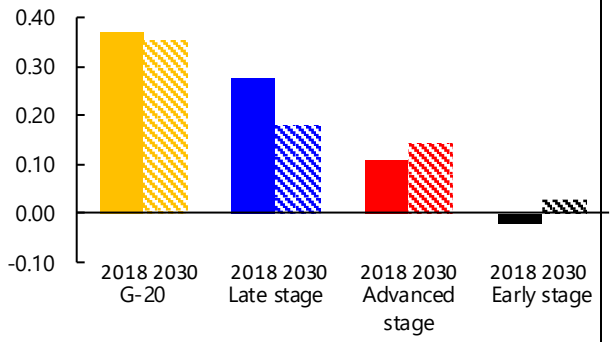
(i.e., they do not capture all influences of demographic change on savings and investment), they should be interpreted with caution and should be viewed as illustrative.[23]

Figure 13. G-20: Current Accounts due to Demographics: Changes and Levels [1/]
(Percent of GDP)



Sources: United Nations (2017); and IMF staff calculations.
1/ Based on EBA-estimated demographic contribution to the norm, with adjustments in low life expectancy countries. For information on the demographic variables used, see footnote 25.

Figure 14. G-20: Current Accounts due to Demographics: Levels [1/] *(Percent of GDP; weighted by G-20 GDP)*



Sources: United Nations (2017); and IMF staff calculations.
1/ Excluded Saudi Arabia due to data limitation. Based on EBA-estimated demographic contribution to the norm, with adjustments in low life expectancy countries. For information on the demographic variables used, see footnote 25.

34. The estimated overall G-20 current account surplus related to demographic variables would decline slightly going forward. The "downhill" capital flows from older/richer to younger/poorer economies highlighted above are projected to be lower in 2030 than in 2018 (Figure 14). Capital flows between demographic transition groups are thus projected to be somewhat lower. This trend would add to an overall decline in the aging-related current account surplus of the G-20 economies. The decline in late stage demographic transition economies' aggregate current account surplus dwarfs the increased surpluses in advanced and early stage countries. The former reflects pressures from a changing age composition among late stage transition countries with rising old age dependency ratios and a declining share of prime age workers, while the latter reflects delayed aging processes relative to late stage demographic transition economies. This would in turn suggest a somewhat reduced downward pressure on equilibrium real interest rates.

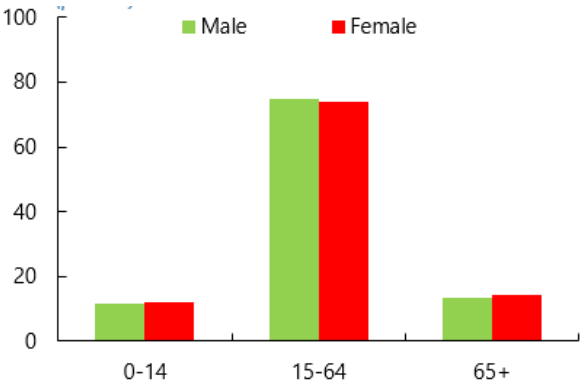
35. The pattern of capital flow movements may be further shaped by differences in financial sector development and institutional setups. As discussed, aging countries with less developed financial sectors and less generous pension systems would tend to exhibit higher savings than comparable countries with more developed financial sectors and more generous pension systems as countries with these characteristics have a larger need for private savings but lack adequate financial

[23] Aging may affect current accounts through channels other than the "purely" demographic variables used for these estimates, notably through desired policies. For example, desired health spending would likely increase due to aging, thus lowering the current account. Aging may also impact the current account through the desired fiscal stance as well as fundamentals like potential growth.

instruments for savers.[24] Exporting savings to countries with better developed financial systems is thus an alternative route to provide for old-age spending needs.[25]

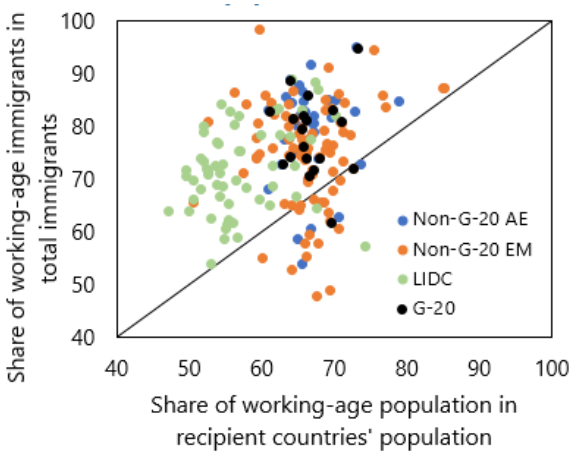
36. Asynchronous aging creates incentives for labor migration. IMF staff analysis shows that migration flows predominantly from early and advanced stage demographic transition countries to late stage demographic transition countries and from early stage demographic transition countries to advanced stage demographic transition countries.[26] In fact, most late stage demographic transition countries have experienced sizable inflows, notably the United States, Canada, Australia and some EU countries and Russia. Moreover, in G-20 countries, the majority of migrants are of working age, and importantly, the share of working age migrants in total migrants is larger than the share of working age native population in total native population (Figures 15-16). Migration, if properly managed, can thus reduce the speed at which the working-age population, and thereby labor supply, falls, smoothing asynchronous demographic patterns across countries. In addition, as IMF analysis has shown, migration can also raise labor productivity.[27]

Figure 15. G-20: Age Distribution of Migrants, 2017 ***(percent)***



Sources: United Nations (2017); and IMF staff calculations.
Note: Percentage distribution of the international migrant stock by age and sex.

Figure 16. Working-age Immigrants and Domestic Population, 2015



Sources: United Nations (2017); IMF staff calculations.
Note: The share of working-age population is calculated as the ratio of population aged 15-64 to total population.

E. Policies

37. G-20 countries will need to pursue a multi-pronged policy approach to aging focused on raising labor market participation and productivity while meeting fiscal challenges. A combination of measures to raise labor force participation and strengthen investment and innovation

[24] See Barany, Coeurdacier and Guibaud (2018).

[25] As countries with more developed financial systems tend to be richer, this can explain "uphill" capital flows from poorer to richer economies.

[26] See Csonto et al. (2015).

[27] See Jaumotte et al. (2016).

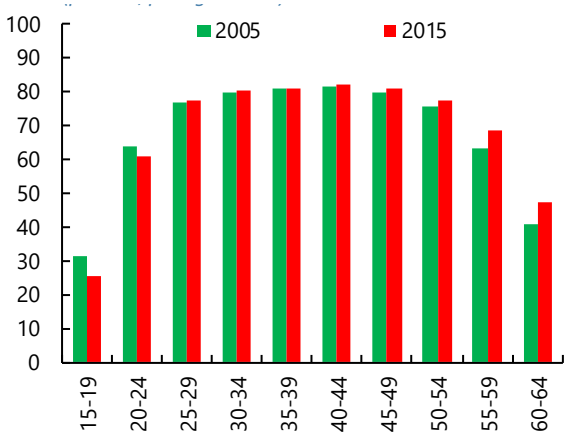
are key responses to mitigate the macroeconomic effects of aging. At the same time, governments will incur higher spending due to health, pension, and long-term care needs of the older population. Policymakers thus face important tradeoffs: should they channel scarce public resources to pay for health and pension obligations or toward investments in infrastructure, R&D, and education which could raise productivity and mitigate the effects of aging? Obviously, optimal policy responses will be country-specific and will depend, among other things, on social preferences and the existing institutional frameworks. International risk-sharing through capital and labor flows could help mitigate these challenges. Finally, since projecting demographic variables involves large uncertainty, policymakers need to stay nimble and should be prepared to deal with a changing outlook, including an even faster transition to smaller populations.

Mitigating the Effect of the Shock:

38. Raising participation and improving human capital helps mitigate the negative effect of aging on the labor supply.

- *Raising older workers' labor force participation*: Healthy older workers could continue working past traditional 'old-age' limits of retirement if governments and the private sector provide the right incentives. First, businesses can provide support for older workers by offering opportunities to retrain and reskill. Second, company practices to offer more flexible contracts and adopt evaluation methods that reward performance rather than seniority or hours worked can also increase participation. Third, governments can relax social security rules that create financial incentives to retire at certain ages in line with increasing life expectancy in order for workers to stay longer in the labor force.[28] Encouragingly, evidence from late stage demographic transition G-20 countries suggests that a combination of such policies has helped reverse some of the decline in labor-force participation rates for older cohorts for both males and females (Figure 17). For example, since the 1990s, many countries have reduced or removed incentives for early retirement by raising the retirement age and moving towards more flexible retirement and stronger incentives to continue working.[29]

Figure 17. G-20: Labor Force Participation Rate ***(Percent; per age chart)***



Source: United Nations (2017); ILO modelled estimates (2017); and IMF staff estimates.

[28] See Gruber and Wise (1998) and Blondal and Scarpetta (1997).

[29] See OECD (2017).

- *Increasing female labor force participation:* Raising female labor force participation could help counter the aging-induced decline in labor supply.[30] First, public policies may have a positive impact on the willingness of mothers to return to paid work or enter the job market if they make it easier to combine work and family such as through tax credits or subsidized access to child care. In addition, having to care for elderly family members is already a prime reason for women to drop out of work. Just as women have tended to leave their jobs to care for children in their 30s, a second "hole in the pipeline" is appearing around the age of 50. However, in Nordic countries and The Netherlands, for example, non-regular workers (including part-time workers) generally receive partial benefits and allowances. Such benefits can facilitate women's labor participation, raise their productivity, and narrow the gender wage gap in the medium term.[31] Second, it is crucial to eliminate fiscal disincentives that might deter women from participating in the labor market, such as taxation of household (rather than individual) income, which raises marginal tax rates for second earners. Third, other policies that directly affect women are linked to addressing gender differences in property rights, inheritance claims, and property titling; enhancing women's ability to pursue a profession, obtain a job, and open a bank account; and enacting laws that give women the right to initiate legal proceedings, sign a contract, and head a household.[32] Fourth, in countries with gender-based legal restrictions, such as constraints on female ownership of real estate or businesses, removing such limits can help lift female labor force participation.
- *Magnifying the effective size of the labor force:* Another strategy involves magnifying the effective size of the labor force by raising human capital through strong investments in health and in educational attainment and quality. Furthermore, encouraging life-long learning can help avoid some of the depreciation of human capital through technological progress and allows longer working lives. A promising strategy in this regard is the preemptive acquisition of new skills by workers to ease transitions between jobs and occupations. Given the uncertainty about future skill needs, education systems will need to be flexible to address market demand.[33] Targeted subsidies or grants could help individuals and firms overcome credit constraints.[34]

Raising Productivity:

39. Increased competition and innovation would help raise productivity. As IMF work has documented, market competition has been declining across advanced economies and on a broad base across sectors since the 1980s.[35] Most advanced G-20 economies would benefit from stronger pro-competition policies that improve inter-firm resource allocation and thus raise efficiency and productivity. More competition could further boost productivity by encouraging firms to separate themselves from competitors through innovation. The optimal policies to foster competition and innovation will differ across countries—for example, increasing the intensity of antitrust enforcement,

[30] IMF (2018b) reviews policies that raise female labor force participation and highlights country examples.

[31] See Kochhar, Jain-Chandra, and Newiak (2017) and Kinoshita and Guo (2015).

[32] See Gonzales et al. (2015).

[33] For detailed discussions on improving the education system, see the World Bank (2018).

[34] See IMF (2018c).

[35] See IMF (2018d) and Diez et al. (2018).

reducing barriers to market entry and exit, supporting research and development including for lagging firms, ensuring that intellectual property rights reward disruptive innovations more than incremental ones. Well-designed patent regimes, for example, will safeguard firms' incentives to innovate. In countries where work forces are already declining, fostering the development and adoption of automation technologies are another promising avenue. Furthermore, improved access to finance, possibly through digital technologies ('fintech'), may be crucial for some countries to foster innovation.

40. Policies to promote economic integration across countries would encourage technological diffusion. Trade, foreign direct investment, and global value chains allow countries to learn from each other, apply best practices, and use the most up-to-date technologies.[36] International knowledge flows have increased over the past decades, providing a positive contribution to global productivity growth. At the same time, greater competitive pressure stemming from a more integrated global economy has been a positive force in stimulating innovation worldwide.[37] To support innovators' international engagement and to fully reap the benefits of technology diffusion across countries, policies need to promote economic integration, provide a level playing field for patent protection across countries, and upgrade regulations to ensure that intellectual property rights protection is competition- and growth-friendly.

Countering Fiscal Pressures:

41. Reforming public pension systems is key. Reforms will be needed in many G-20 countries to achieve a balance among a multitude of objectives, including ensuring pension sustainability, maintaining appropriate national saving levels and providing adequate old-age support. The appropriate responses to the aging challenge will vary across countries and account for country-specific policies and institutional settings, including how pensions are determined and financed.[38] In countries where public pension system reform is particularly challenging, alternative measures such as automatic adjustment mechanisms can be considered.[39]

- *Sustainability considerations*: In countries where the sustainability of the public pension system is at risk, reducing pension generosity (for example, curtailing early retirement benefits or reducing benefit ratios) and raising the retirement age (in line with the increase in life expectancy) would help ease rising pension spending pressures. An added benefit for such countries with low saving rates is that a lower pension generosity could induce more private saving and boost the level of national saving.
- *Equity considerations:* While ongoing and planned pension reforms will improve pension system sustainability, average benefit ratios are projected to decline sharply in many countries. This, in turn, implies that the distributional consequences of pension system reform could be significant. In this context, future pension reforms would need to be carefully calibrated to avoid undercutting

[36] See Keller (2004).

[37] See IMF (2018e).

[38] See Amaglobeli et al. (2019).

[39] See Arbatli et al (2016).

the welfare of future retirees and fueling poverty among the elderly. For instance, when linking increases in retirement age to longevity gains, adequate provisions should be made for the poor, whose life expectancy tends to be lower than average. Antipoverty programs should be carefully designed and targeted.

- *Pension system architecture considerations*: The pension system architecture could be improved to boost private saving. For instance, IMF research suggests that the presence of a DC scheme can support higher saving rates. Countries with an enabling environment might consider complementing the public pension scheme with a funded DC scheme. Fiscal incentives to encourage retirement saving should also be considered. (e.g. providing tax-preferred saving vehicles related to pensions, such as the 401(K) plans in the United States). On the other hand, in countries with inadequate pension systems which put the burden of financing consumption for old age mainly on precautionary private savings (e.g. China, Korea), the pension system should be strengthened by expanding coverage or raising replacement rates, as well as enhancing targeted social transfers, so long as the room for fiscal maneuver exists.

42. Healthcare system reform can mitigate fiscal pressures from aging. Containing the growth of healthcare spending while ensuring adequate delivery of healthcare services is an urgent priority. Countries could pursue health care spending reforms in a number of ways and depending on their unique circumstances: by increasing competition among insurers and service providers, improving the provider payment system to control costs, paying more attention to primary and preventive health care, and making more effective use of health information technology.[40] Technology also holds great promise to make life better for the elderly, lend a helping hand to those who care for them, and importantly helps prevent expensive healthcare and long-term care costs.

43. Aggregate fiscal policy will have to adjust. Reduced public saving and lower nominal GDP growth would both be factors leading to an increase in a country's debt-to-GDP ratio, unless lower interest rates compensate these effects. As many countries will find it hard to fully offset the effect of demographics on age-related spending, they will have to strengthen their fiscal frameworks, improve their tax systems, and generate efficiencies in public spending programs outside of pensions and health. Countries should consider introducing credible medium-term fiscal frameworks to secure debt sustainability. In addition, they may need to adjust both their tax systems and their expenditure priorities. On the tax side, this could include shifting the burden of taxes from labor to consumption, broadening the base for value-added taxes, strengthening taxation of multinational corporations, making greater use of energy taxation to get energy prices right and account for environmental and other costs of energy use, better using opportunities for recurrent property taxation, and strengthening tax compliance.[41] On the expenditure side, countries should strive to improve public spending efficiency while ensuring adequate fiscal support for labor market policies aimed at boosting labor force participation and upgrading human capital.[42]

[40] Clements, Coady, and Gupta, 2012.

[41] See IMF (2013). See also McGrattan, Miyachi and Peralta-Alva (2018) for a discussion of appropriate tax policies to finance old-age related spending.

[42] See IMF (2012).

Avoiding Monetary Policy Mistakes and Putting the Financial Sector at Work:

44. Monetary policymakers will need to monitor the effects of aging. While the path of equilibrium real interest rates is uncertain, its direction could impact central banks' ability to steer inflation towards target. If rates 'normalize' back to higher historical levels, the conventional, well-known toolbox of monetary policy instruments will be available again. If, in contrast, interest rates remain low or fall further, the zero lower bound may become an even tighter constraint and may apply in more countries. In the latter case, it will be important to draw lessons from the use of unconventional monetary policy tools in the past decade.[43] Furthermore, the ongoing research on the determination of equilibrium rates of interest will hopefully result in an improved assessment of desired policy rates.

45. Financial services should adapt to the needs of an aging society. The services provided by the financial industry, as well as the business models of financial institutions, will need to match the demands of an aging population. First, given relatively flat term structures that drive compressed net interest margins, banks will need to increase fee-based income, namely by charging for basic banking services. Second, rising longevity could boost the demand for long-term care insurance. Finally, given an environment of low asset returns caused in part by aging, demand for guaranteed-return savings products offered by insurers could weaken, while that for low-fee passive index funds offered by asset management firms would likely grow (IMF 2017a). Policies could help ease the adjustment of business models of financial institutions and the expected changes to the financial landscape. In addition, authorities should engage with financial institutions on the implications of macroeconomic and demographic trends for their sector.

Allowing Global Risk Sharing:

46. Aging-induced current account movements are helpful. Current account movements (and associated exchange rate changes) reflecting asymmetric demographic developments across countries are welcome as they indicate global risk sharing at work. Higher returns to capital abroad generate welfare gains for both sender and recipient countries although distributional aspects should not be ignored. Furthermore, there are positive spillovers from policies that raise productivity across countries so that the mitigating effects of aging are widely shared. However, current account swings could also be driven by 'wrong' policy choices (e.g., failure to facilitate technological change or making the wrong decisions on fiscal and pension systems) which can come at a welfare cost from a domestic perspective and exacerbate unwanted cross-country spillovers.

47. Well-managed migration can further help relieve macroeconomic pressures from aging. Given the staggered nature of demographic change, increasing migration would relieve spending pressures—at least until migrants age and retire. Increasing migration should not, however, be a substitute for more fundamental reforms of entitlements as migration alone does not alter the balance between public benefits received and taxes paid by individuals over their lifetime. Nevertheless, migration can give recipient countries time to implement needed aging-related reforms. Fast labor

[43] See, for example Kuttner (2018), and Dell'Ariccia et al. (2018).

market integration of migrants—though challenging--is essential for harnessing the benefits of immigration and generating positive contributions to public finances. For some countries, encouraging foreign workers, including through guest worker programs that target specific skills, could be the way forward. 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.[44]

International Coordination:

48. As there is a significant international dimension to aging issues, G-20 countries would benefit from:

- *Sharing information*: given that many of the expected policy challenges occur in clusters across countries, there is a strong case for sharing experiences and best practices.
- *Maximizing positive spillovers:* Productivity gains and their positive spillovers can help all countries and can be maximized by strengthening international/multilateral frameworks for trade, investment, and protection of intellectual property rights.
- *Enhancing coordination:* there are areas where international cooperation is a must, including coordination around freer movement of capital and labor. Capital flows can support investment in countries with young populations where returns are high, while enhanced policy coordination is essential to effectively address humanitarian migration crises while leveraging benefits from enhanced international labor mobility.

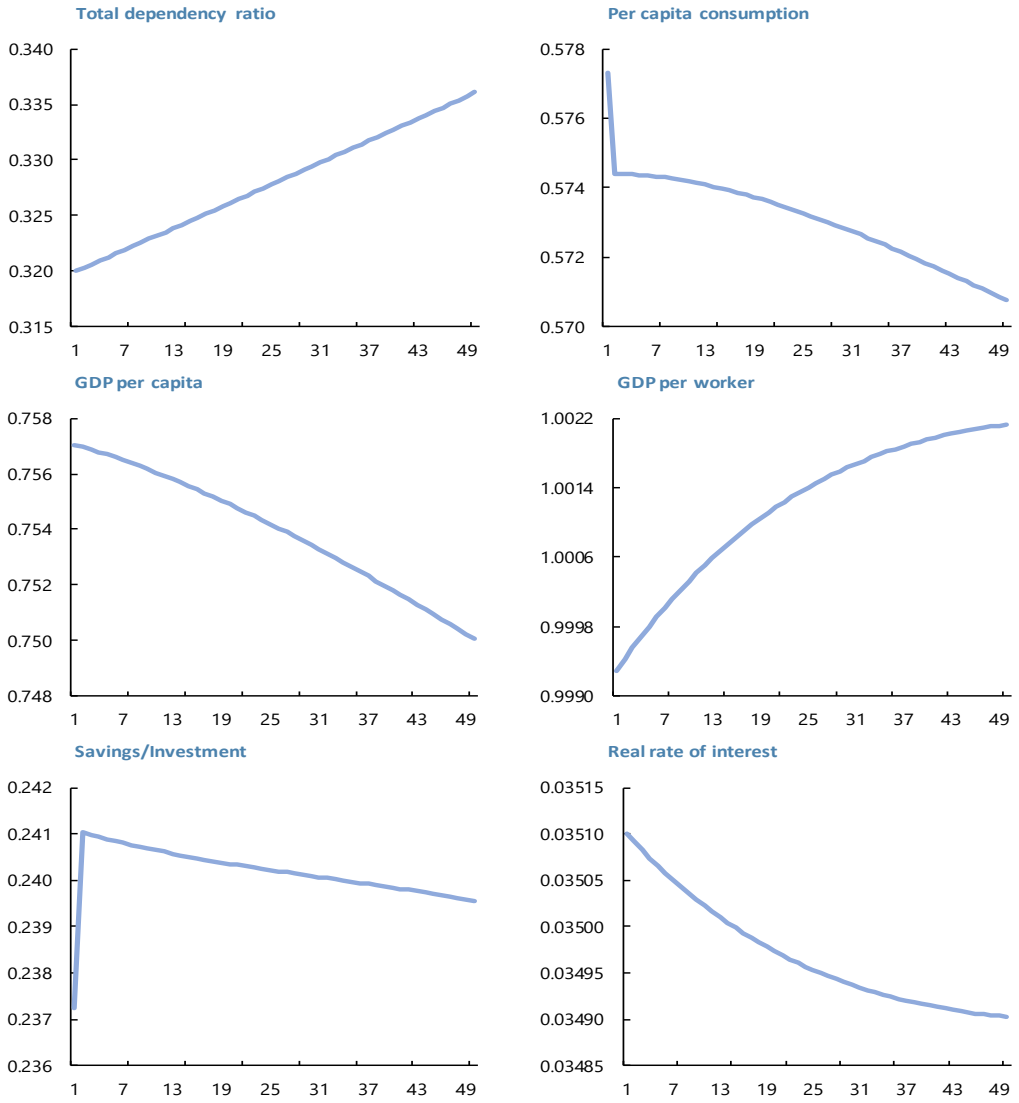
[44] Another important aspect, though beyond the scope of this paper, is the effect of emigration of sending economies as it may have long-lasting negative implications for potential output. For a discussion with a view on Central and Eastern European economies and policy implications see Atoyan et al. (2016).

Box 1. A Stylized Model

The main macroeconomic channels affected by aging can be characterized by a simple neoclassical macroeconomic model of a closed economy with a representative household where the total dependency ratio is assumed to rise over many years. The panel charts below illustrate the expected behavior of some of the key variables of this model. In particular:

- Per capita GDP and consumption decline over time because a smaller workforce produces a smaller economic pie that must be distributed across the population.
- Saving and investment initially rise to prepare for an even higher dependency ratio in the future.
- The higher capital-to-labor ratio implies an increase in productivity as GDP per worker rises.
- The real rate of interest, which balances the supply of saving and the demand for capital, falls as the higher capital to labor ratio reduces the marginal return on capital.

An increase in total factor productivity would mitigate some of the above effects. On the other hand, a return of the dependency ratio to its original level would reverse the above trends. This could occur through higher fertility or immigration as well as a higher labor force participation rate.



Source: IMF staff calculations.

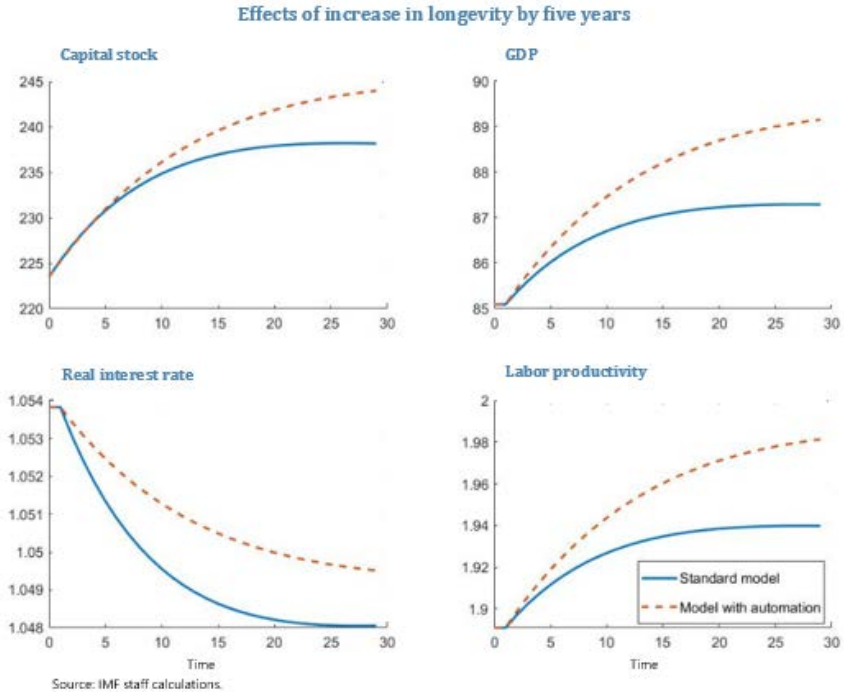
Box 2. Effect of aging on productivity

The literature on the macroeconomic effects of aging has almost exclusively focused on its implications for the supply of saving by households. In contrast, few studies have focused on firms' demand for saving for investment purposes in the context of demographic change.

A new strand of literature attempts to fill this gap by shedding light on firms' technological decisions in the form of automation, often described as the decision to replace labor with robots. Recent work by He and Piazza (2018) builds on a model that allows for demographic transitions to influence firms' decisions about the set of production tasks to automate (see also Gertler (1999) and Acemoglu and Restrepo (2017)). Allowing firms to perfectly substitute capital (i.e. robots) for labor at the task level is an innovative approach, since the traditional literature assumes that the set of tasks performed by either labor or capital is fixed.

In this framework, population aging has macroeconomic implications through its effect on the abundance of both labor and saving from the household sector, which firms use to finance their investments. The change in the abundance of labor and capital, and thus in their relative cost, affects firms' incentives to automate production tasks (i.e. substitute capital for labor).

The model is used to study quantitatively the macroeconomic effects of various aging shocks: greater longevity, lower fertility, and various aging-related policies such as pension reforms. The findings suggest that a positive longevity shock gives rise to a transition period of a higher capital stock, output, real rates of interest, labor productivity and wages than under a standard model where the proportion of tasks performed by either labor or capital is fixed (see Figure). This is due to the fact that a positive longevity shock induces households to save more in anticipation of a longer retirement period. Without the possibility of automation and the ensuing additional investment, this would decrease the equilibrium real rate of interest, which in turn would attenuate saving incentives by households. Instead, when automation is allowed in the model, firms absorb the increased saving by making their production technology more capital intensive - i.e. by automating production tasks. Endogenous automation thus acts as a buffer against demographic shocks.



Box 3. The Future of Saving: The Role of Pension System Design in an Aging World

Recent IMF work (Amaglobeli et. al., 2019 and Chai and Kim, 2018) investigates how impending demographic shifts and the design of pension systems could influence future national saving. It illustrates how countries' position along the demographic transition and pension system characteristics result in differential paths for private and public saving rates.

Theoretical analysis using a small, open-economy overlapping-generations model shows that the attributes of public pension systems (coverage of the elderly, benefits, and the type of funding) can influence workers' consumption-versus-saving decisions. The impact on private saving depends largely on pension system generosity and the presence of dedicated pension saving accounts that promote private saving. With a more generous public pension system, retirees will have to rely less on private saving. Low benefit ratios or low coverage can induce higher private saving, as people save on their own to avoid a large drop in their living standards at retirement. There is significant cross-country heterogeneity along these dimensions.

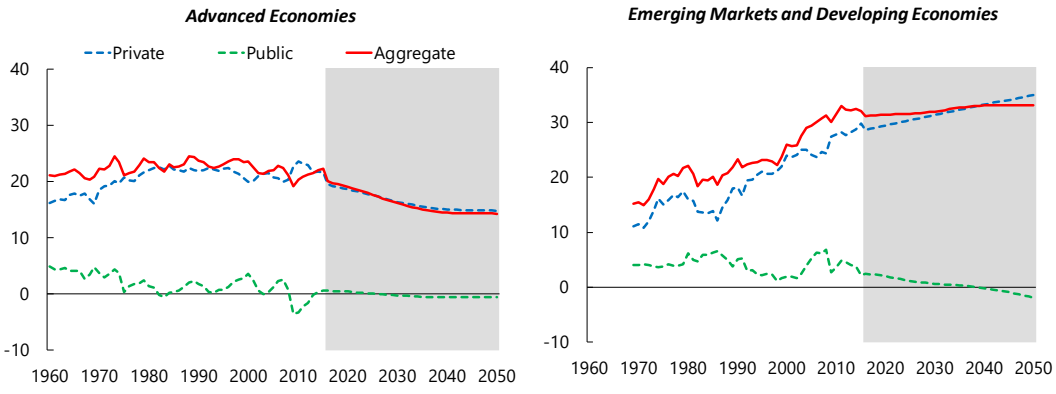
How will forthcoming demographic changes affect private saving and public finances, and thus national saving, through 2050?

-Model coefficients from a cross-country panel analysis are used to project private saving as a function of demographic factors (changes in old-age dependency ratios and life expectancy), pension system characteristics (pension generosity and the existence of a DC system), and projected public saving (owing to changes in public pension spending). Demographic variables are assumed to evolve in line with the United Nations' medium-fertility variant scenario, while other determinants of private saving, including pension system characteristics and macro variables (real GDP growth, GDP per capita, inflation, terms of trade, employment rates, private credit-to-GDP ratios, and real interest rates) are held constant.

-Public saving projections use national authorities' projections for future pension spending, which incorporate assumptions about reforms adopted to date, including changes that will take effect in the future. It is assumed that projected increases in public pension spending translate fully into lower public saving.

Saving Projections by Country Groups

(percent of GDP)



Source: Amaglobeli et al (2019).
Note: Projections in 2016 and later years include data for 74 countries that accounted for over 80 percent of world GDP in 2016.

Worldwide, public pension spending pressures could depress public saving by just over 2 percentage points of GDP by 2050, with significant differences across countries. Reflecting recently-enacted reforms, public saving in most advanced economies could fall modestly (by about one percent of GDP) between now and 2050. The projected decline in public saving is larger for emerging markets and developing economies and is particularly pronounced for countries experiencing rapid aging and those in which pension systems have yet to be reformed.

The evolution of private and national saving depends on the interaction of demographic developments with pension system attributes. Assuming unchanged country weights, global saving could potentially decline by

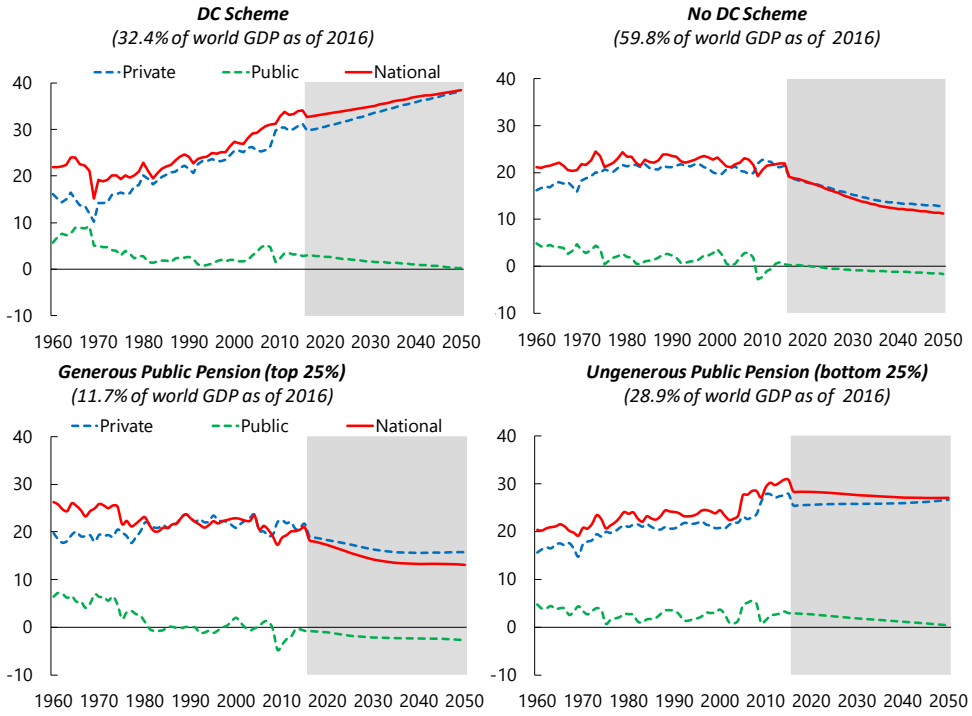
Box 3. The Future of Saving: The Role of Pension System Design in an Aging World (Concluded)

about 3 percentage points of GDP between now and 2050. In emerging markets and developing countries collectively, higher private saving by relatively younger populations offsets the projected decline in public saving, resulting in broadly stable national saving. In contrast, private saving rates in aging advanced economies are expected to contract sharply, leading to a steep overall decline in aggregate saving rates.

Saving projections differ markedly depending on pension system generosity and the presence or absence of a DC scheme. Private saving is projected to increase in countries with DC schemes, on average by about 8 percentage points of GDP by 2050. This effect more than offsets the projected decline in public saving owing to the simultaneous presence of PAYG public pensions. In contrast, private saving is expected to decrease by about 6 percentage points of GDP in countries with only PAYG pension schemes, as the system does not encourage higher wealth-holding by individuals.

Saving Projections by Type of Pension System

(percent of GDP)



Source: Amaglobeli et al (2019).
Note: World GDP is calculated as the sum of the US dollar values of the countries. Generosity grouping is based on the data for 2015.

This, in combination with higher age-related public pension spending, would lead to a substantial decline in national saving. In general, benefit generosity pushes up pension spending, weighing down public saving.

Private saving is lower in countries with higher public pension generosity as retirees need to rely less on their own saving. Thus, aggregate saving in countries with generous public pension systems is projected to decline sharply. Conversely, inadequate pensions can drive up private saving, as they induce retirees to save more for their mainly self-funded retirement. This effect is especially pronounced when precautionary motives against longevity or earnings risk are an important component of household saving decisions. In countries with the least generous public pension systems, private saving is therefore projected to increase slightly by 2050.

Other IMF work (Dao and Jones, 2018) complements the above analysis by taking into account uncertainty over the future sustainability of the pension system and expectation of future pension cuts due to high generosity or fast aging under natural limits to taxation and shows that these considerations could lead to further private precautionary saving.

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APPENDIX I. POPULATION DATA

1. Population data come from the UN Population Division. The data used in this paper as in a predominant part of the literature are the medium variant population projection. The medium variant is based on assumptions about a) fertility rates b) life expectancies, and c) international migration. It corresponds to the median of several thousand projected trajectories of specific demographic components.

- The medium variant assumes a decline of fertility for countries where large families are still prevalent, as well as a slight increase of fertility in several countries where women have fewer than two live births on average over a lifetime.
- Projections starts with actual population by age and sex in 2015 and extend out to 2100 based on expected trends in fertility, mortality and net international migration, computed according to the methodology used in the 2012 Revision of World Population Prospects (United Nations, 2013b).

2. Population aging is the rising average age of the population and is driven by the following factors:

a) **A fertility rate that is lower than in previous generations.** This adds younger cohorts that are smaller than older cohorts thereby raising the average age of the population.

b) **An increase in life expectancy caused by higher survival probabilities (lower mortality rates) for all cohorts.** This raises the size of all cohorts, which per se does not need to increase the average age. Survival probabilities must increase more for older cohorts to increase the average age.

c) **Momentum**. Captures the dynamics of the already-born population. If fertility were to return to the replacement level and survival probabilities at all ages remained constant, then the average population age would *fall* if older cohorts are larger than younger ones because larger older cohorts would die and be replaced by younger cohorts.

3. **Migration**: Projected levels of net migration are kept constant in the near-term. After 2050, net migration is assumed to decline gradually and reach zero by 2100. Positive net migration (immigration – emigration) will contribute to population increases, while negative net migration will have the opposite effect.

4. **Demographic components to medium variant population growth projections:**

i) effect in migration = medium variant – zero migration
ii) replacement = instant replacement - effect of migration
iii) fertility = medium variant - replacement
iv) mortality = replacement - momentum

5. The methodology used to decompose the future population growth of the G-20 countries follows the method proposed by Bongaarts and Bulatatao (1999) and that used by the 2012 Revision of the World Population Prospects (United Nations, 2013b). More specifically, a set of projections on future population trajectories is made starting from 2015 and going up to 2050.

6. As a first step, a Standard Population projection is set, using population by age and sex. The projection is set equal to the UN medium fertility variant and takes into account specific population projection variants, namely fertility, mortality, and net international migration.

7. The second step is to estimate the Natural Population projection variant, through subtracting net migration from the Standard variant. We then subtract the Natural variant from the Standard one, to find the effect of net migration on future population growth.

8. The Replacement projection follows, which is calculated through the difference between instant replacement and the effect of migration. Based on this calculation we also determine fertility, subtracting replacement from the medium variant.

Finally, the Momentum projection variant is built, assuming zero migration and taking 2015 constant mortality rates and constant fertility at the replacement level. Mortality is then estimated as the difference between replacement and momentum.