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

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EXECUTIVE SUMMARY

Over the coming decades, declining fertility and increasing longevity will profoundly change the population age distribution in many countries, albeit at different paces. The fiscal consequences of this demographic transition have received considerable policy attention around the world, but what implications will it have for saving rates across countries? What role does the design of retirement systems play?

This discussion note investigates how impending demographic shifts and the design of pension systems could influence future national saving. National saving—the sum of public and private saving in a country—is the main source of financing for domestic investment, even in a world with high capital mobility. It also plays a crucial shock-absorbing role, with implications for growth and economic stability. In countries with aging populations, national saving is important to bolster retirement security and allow workers to more easily bear the costs of financing pension programs while maintaining their living standards. This note focuses on the interplay between public and private saving, and the role of pension system attributes (coverage of the elderly, benefits, and the type of funding) in shaping saving profiles across countries in the coming decades.

Under current policies, public pension outlays in advanced and emerging market economies will increase by an average 1 and 2½ percentage points of GDP, respectively, by 2050. Without adjustment in taxes and other spending, this increase will lead to a commensurate decline in public saving. In many advanced economies, younger people will have to save significantly more and postpone retirement by a number of years to enjoy pension benefits similar to those of today's retirees. While countries with aging and shrinking working age populations are projected to experience a more significant drop in national saving than those with younger populations, the design of pension systems will affect the evolution of saving. Private saving will decline more precipitously in countries with generous public pension systems, as people will rely less on their own savings when they retire. All else being equal, private saving is projected to increase in countries that include a defined contribution scheme as part of their pension systems. Measuring saving, accounting for the effects of uncertain demographic changes, and predicting the future of such trends are inherently challenging endeavors. The projections in this note should be considered illustrative, and they do not include an opinion on the optimal saving rate or the desirable level of pensions.

The findings of this note raise important policy considerations:

- Encouraging higher private saving for retirement and attenuating long-term fiscal vulnerabilities will require further public pension reforms in many emerging market and advanced economies, but reforms must be carefully calibrated to avoid undercutting the welfare of future retirees or fueling old-age poverty. In countries with relatively high saving rates and inadequate social security systems, improving pension generosity may be warranted to reduce the need for excessive private saving.
- Countries with an enabling macroeconomic and legal environment and sufficiently developed financial systems could consider complementing the public pension scheme with a funded defined contribution scheme. This would provide a vehicle to encourage private saving. More ambitious reform to the pension system architecture, including shifting from a pay-as-you-go to a funded system, should be carefully weighed against transition costs to the budget.
- Financial sector and labor market policies should be considered as part of a pension reform package. The ability of households to save for retirement and to diversify retirement-related risks will depend on the availability of a wide array of relevant financial products. Labor market policies should be geared toward encouraging participation by older workers, attenuating gender gaps, and tackling informality.

INTRODUCTION

1. Looming aging challenge and saving. Many advanced and emerging market economies are facing rapid, unprecedented aging of their populations, driven by declining fertility and rising life expectancy. Previous work (for example, Clements and others 2015) has shown that population aging and dwindling working age populations could place significant pressure on public pension systems, eroding public savings.[1] This is because more retirees will receive benefits while fewer people will work and contribute to the system through taxes. Not surprisingly, policy debates around the world have focused on the long-term sustainability and requisite reform of pension systems. However, less attention has been devoted to prospects for private, and hence aggregate, national saving. How will the forthcoming demographic shifts affect private saving decisions? Will the design of pension systems have differential implications for private and aggregate saving patterns across countries?

2. Interaction between public and private saving. Saving patterns typically change with age: the young borrow, prime working age individuals save, and the old dissave after retirement. Aging is thus likely to depress private saving as the percentage of elderly people in the population rises, and longer lifespans mean that people might need to save more for retirement throughout their working lives. The impact of demographic changes on private saving decisions will depend, among other factors, on the design of government pensions and social safety nets.[2] Variation in the availability, structure, and coverage of pension systems around the world could influence individuals' saving decisions. For instance, lack of development and coverage of pension systems could cause households to save too little for retirement, particularly if financial markets do not offer appropriate saving instruments. However, insufficient coverage could also encourage excessive precautionary saving. On the other hand, overly generous pension regimes featuring early retirement provisions could create disincentives to work and affect saving behavior. The interaction between aging and pension systems is therefore crucial to understanding private saving behavior and its evolution across countries.

3. Why does this interaction matter? At the individual level, savings provide households with a cushion to smooth consumption and plan for the future. For those coming of working age now, pensions won't provide as large a safety net as they did for earlier generations. In many countries, efforts to address the financial sustainability of pension systems by reducing pension generosity could force the future elderly to live in poverty. Furthermore, because most household saving is done by the highest income earners, lack of savings could be a particularly acute problem for the poor. At the macro level, understanding the implications of demographic developments and pension system characteristics for future saving is critical, as national saving is an important source for financing domestic investment and absorbing country-specific shocks, with implications for

[1] This effect will likely be magnified by burgeoning age-related expenditures (including health spending), which are not the focus of this note.

[2] In addition to demographic trends and pension arrangements, aggregate saving rates in an economy depend on several factors, including income growth and how it is distributed across generations, people's income at different stages of life, the existence of asset markets that permit households and firms to shift consumption from the present to the future, individual preferences, and varying levels of tolerance for uncertainty.

growth and economic stability. The saving rate also determines how fast a country can rebuild buffers at a time of historically high global debt (IMF 2018b). Motives for personal saving and the design of pension systems could also directly influence individual saving behavior, thereby affecting the overall net foreign asset position of a country and the composition of investment portfolios (Staveley-O'Carroll and Staveley-O'Carroll 2017; Eugeni 2015). This has implications for the dynamics of international capital flows, external imbalances, and global interest rates.

4. This note. This note investigates how forthcoming demographic shifts and the design of retirement systems could influence saving rates across countries. Building on previous studies that highlighted the fiscal consequences of aging, this analysis focuses on the interplay between public and private saving, as well as the role of pension system attributes (coverage of the elderly, benefits, and the type of funding) in shaping saving profiles across countries in the coming decades. The findings suggest that differences in countries' progression along the demographic transition will interact with their pension system characteristics, resulting in differential paths for private and public saving rates. Aggregate saving is influenced by the promise of generous retirement benefit payouts; rapidly aging countries with generous public pension systems could experience a precipitous decline in both public and private saving. The results also suggest that the aging-related decline in private saving could be mitigated by funded defined contribution (DC) pension systems.

5. Caveats. The analysis does not provide an assessment of the optimal level of saving or the desired degree of generosity of a pension system (IMF 2018a). In addition, aggregate saving in an economy depends on the distribution of income within and across generations, with welfare implications that are not explicitly addressed in this analysis. The analysis also abstracts from behavioral changes and an explicit examination of the demographic impact on growth and productivity. Finally, the note does not examine the consequences for saving of the transition from a pay-as-you-go (PAYG) system to a fully funded system, which can be ambiguous. With those caveats, the partial equilibrium analysis in this note offers simple inferences on the evolution of public and private saving across different countries under a no-policy-change scenario.

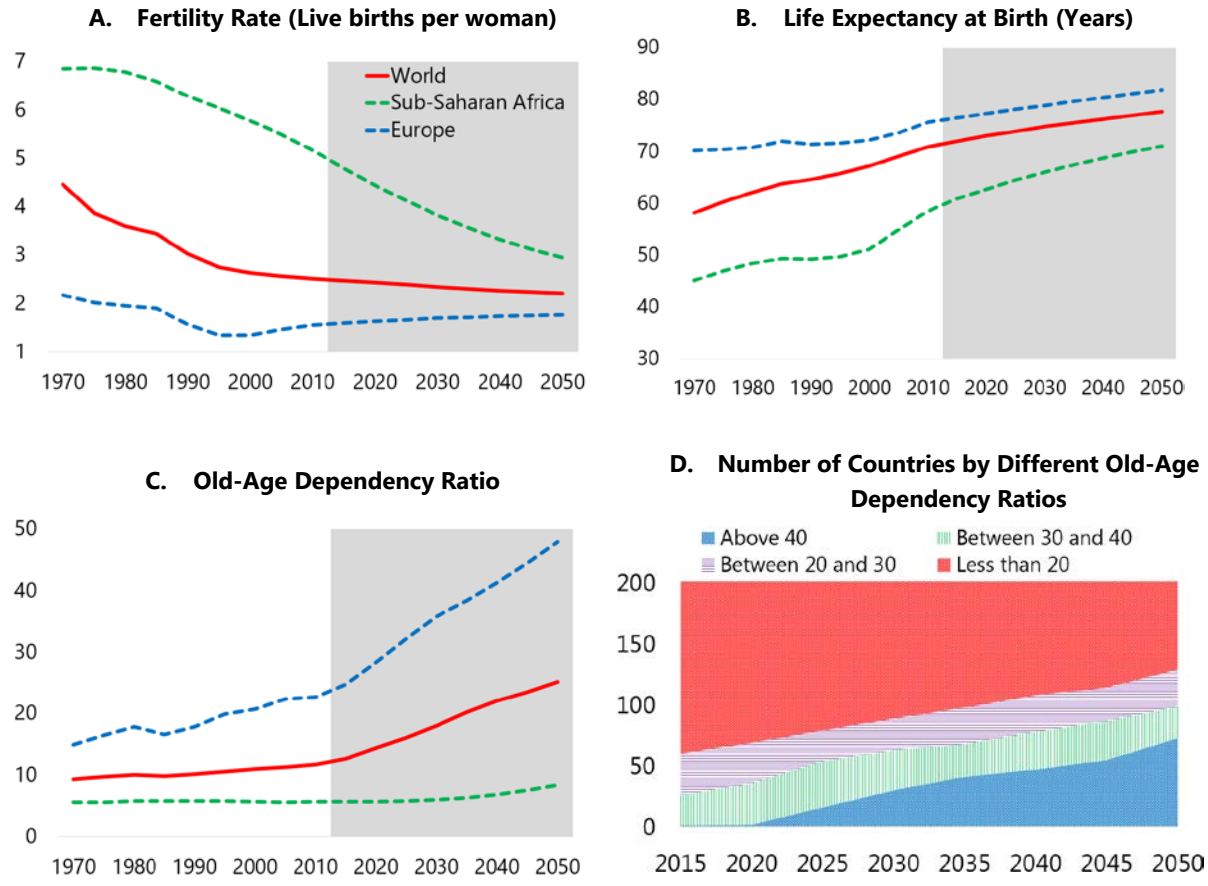
6. Roadmap. The next section provides an overview of demographic developments and the current design features of pension systems around the world. It includes a simple overlapping generations (OLG) model to illustrate the channels through which demographic variables (longevity, fertility, old-age dependency) affect both public and private saving. The model provides intuition for empirical estimates of the impact of demographic factors and pension system design on private saving. The estimation results are used in conjunction with public pension spending projections to simulate potential paths for the evolution of national saving rates. Finally, policy implications for improving pension systems and alleviating other structural impediments to saving (for example, financial market constraints and labor market imperfections) are discussed.

DEMOGRAPHIC AND PENSION SYSTEMS TRENDS

A. Demographic Trends

7. Aging societies. The global population is undergoing a significant transition; after a record increase in the 20th century, population growth is decelerating.[3] Declining fertility rates, combined with increased life expectancy, will result in older populations in the coming decades (Figure 1). In many countries—especially Japan and some European countries—fertility rates are below those required to replace the population. At the same time, life expectancy at age 65 is projected to increase by around a year per decade. As a result, by 2050, on average, the old-age dependency ratio—the ratio of the elderly population (65 years and older) to the working age population (15–64 years)—will double. Today, Japan is the only country with an old-age dependency ratio over 40; by 2050 more than 55 countries will exceed that ratio.

Figure 1. Demographic Developments



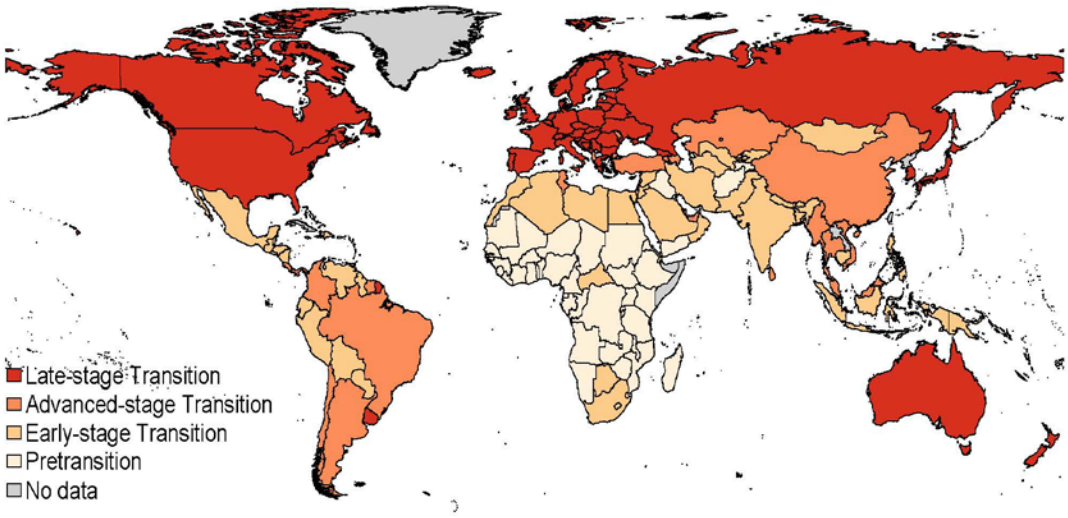
Sources: UN World Population Prospects 2016; and IMF staff calculations.
Note: Population weights are used to sum across country groups.

[3] In the 20th century, the world population increased from 1.5 billion to 6.1 billion—three times the increase over the entire previous history of humanity (Roser and Ortiz-Ospina 2017).

8. Asynchronous demographic transitions and implications. Countries are at different stages of the demographic transition (Figure 2 and Annex 1). The pace and timing of the transition will have different implications across countries for labor supply and for private and public saving rates.

- Most advanced economies and some emerging market countries (for example, Russia and Ukraine) are in the *late stage* of demographic transition, with aging well underway and the working age population declining or about to decline. United Nations projections suggest that the working age population will fall by about 20 percent in Europe between 2015 and 2050 and by almost a quarter in Korea. In the United States, Australia, and New Zealand, however, the working age population will still be growing over this period. A lower share of workers in the population means that output per capita will fall and national saving rates could potentially decline, owing to increased transfer payments to and lower private saving rates among the growing elderly cohort.
- Other emerging and some developing countries (for example, China and some countries in Latin America) are at an *advanced stage* of demographic transition, having already enjoyed the bonus of a demographic dividend—a period during which the working age population expands relative to the young and the old. More workers makes it easier to take care of a relatively smaller pool of elderly people through intergenerational transfers (pensions or intrafamily transfers) and contributes to higher saving rates in some countries. This bonus has now ended in many countries in this group and will end very soon for the rest.
- In countries at an *early stage* of demographic transition (for example, India, Mexico, Indonesia, and countries in the Middle East and North Africa), fertility rates are declining but remain relatively high, with the share of working age population expected to peak in coming decades.
- Countries in the *pretransition* demographic phase (mainly countries in sub-Saharan Africa) have yet to experience the benefits of a demographic dividend (IMF 2015a) and are not the focus of this note.

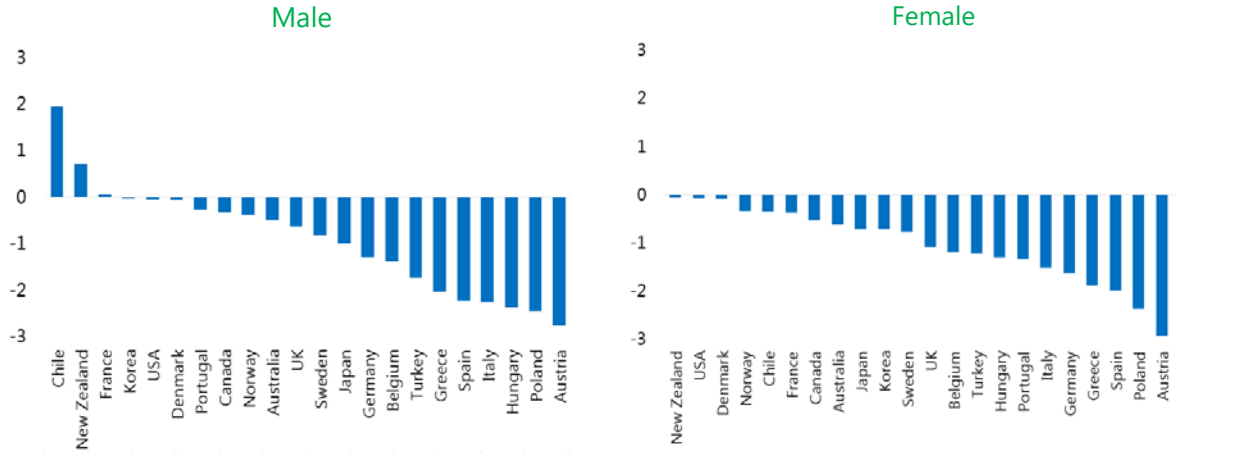
Figure 2. Demographic Transitions across Countries



Sources: United Nations World Population Prospects 2016; and IMF staff calculations.
Note: The *k*-means clustering method was used to create four groups of countries based on their current state in the demographic transition (see IMF 2015b, Annex 1).

9. Workforce aging, labor force participation, and saving. The rapid aging of the labor force in countries at the late and advanced stages of demographic transition is already shifting the composition of the workforce from relatively young to relatively old workers. Workforce aging can affect national saving, as saving rates typically differ by age: individuals borrow when they are young, save during their working years, and deplete their savings once they reach retirement. Aging can also affect labor force participation, as the elderly tend to participate in the labor force at much lower rates.[4] Assuming that age and gender cohort-specific labor force participation rates remain unchanged from 2015, the projected change in the age structure of working age population in favor of older age cohorts could lower labor force participation for both men and women (Figure 3).[5] The resulting decline in aggregate labor force participation would weigh on the sustainability of social security systems by lowering the ratio of contributors (workers) to beneficiaries (pensioners), a trend that is exacerbated where the working age population is expected to shrink.

Figure 3. Projected Changes in Labor Force Participation Rates, 2015–50 (Percentage points)



Sources: OECD (2017); and IMF staff calculations.

Note: Projections are based on population projections under the United Nations' medium fertility scenario as weighted averages of age and gender cohort-specific labor force participation rates, which are assumed to be constant.

B. Pension Systems and Aging

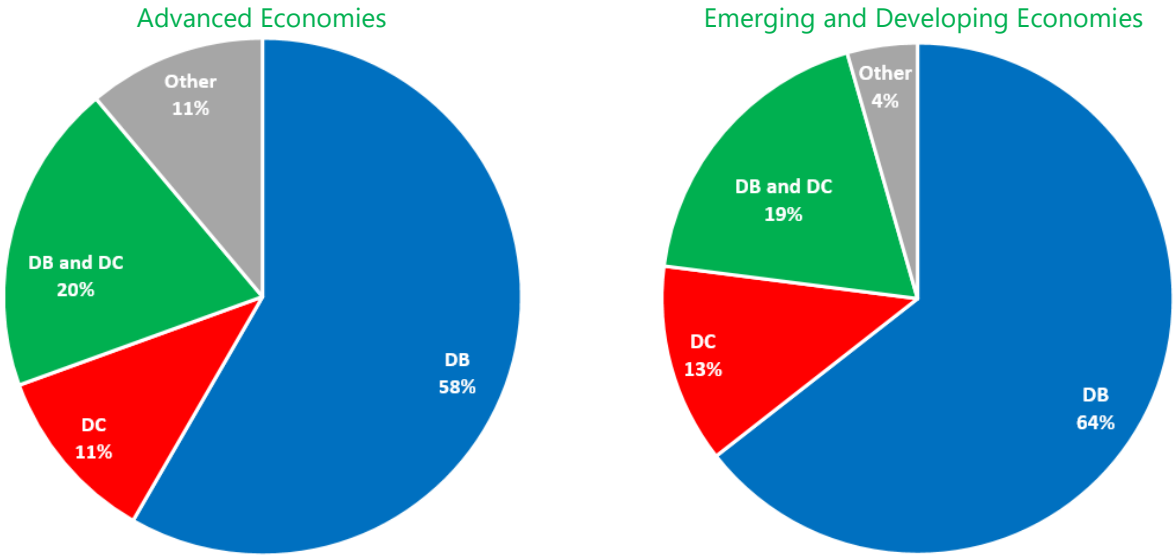
10. Architecture of pension systems and aging. Differences in pension system arrangements and their funding have important implications for how aging could affect saving (see Box 1 for a taxonomy). Most countries rely on defined benefit (DB) pension schemes, under which benefits depend on the number of years of contributions and the individual's earning history, typically complemented by a means-tested basic pension (Figure 4). Some countries have defined

[4] Workforce aging may have already weakened productivity growth by as much as 0.2–0.5 percentage point per year, on average, across advanced economies, and 0.1 percentage point on average across emerging and developing economies, from the 1990s through the 2000s (Adler and others, 2017; Aiyar and others, 2016).

[5] These projections hold only if past patterns of labor force participation by age and gender continue. Over the past 35 years, the increase in labor force participation rates of working-age women in Organisation for Economic Co-operation and Development (OECD) countries outweighed the reduction in labor force participation rates of older men, reflecting a combination of declining fertility and government policies to encourage female employment (Elborgh-Woytek and others 2013). But a pronounced gender gap remains in many countries (for example, in Chile, Italy, Korea, and Turkey).

contribution pension systems based on individual accounts, which often coexist with the DB scheme. Pension systems also differ in the extent to which liabilities are prefunded. 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. This difference in funding structure implies that aging (by increasing the ratio of elderly beneficiaries to younger workers who fund benefits) is likely to have a direct impact on *public saving* in PAYG schemes and (through the life-cycle theory of saving) on *private saving* in DC systems.

Figure 4. Design Features of Mandatory Old-Age Pension Systems around the World, 2015



Sources: US Social Security Administration (2015-16); and IMF staff calculations.
Note: Charts are based on data for 36 advanced economies and 135 emerging and developing market economies. DB includes traditional defined benefit as well as basic pension schemes (flat rate or means-tested). DC includes mandatory individual account schemes. Other includes basic pension schemes only. DB = defined benefit; DC = defined contribution.

11. Public pension system parameters and private saving. The parameters of public pension systems can influence workers' consumption-versus-saving decisions. The impact on private saving depends largely on pension system generosity, which encompasses both the size of benefits per person (the benefit ratio) and the coverage (the percentage of elderly people who receive a pension). With a more generous pension system, retirees will have to rely less on private saving. As a corollary, 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 standard at retirement.[6] There is significant cross-country heterogeneity along these two dimensions (Figure 5). In Europe, for instance, Greece and Cyprus provide pension benefits that are about 65 percent of the average economy-wide wages. The corresponding number is less than 30 percent in Latvia and Ireland. Advanced economies provide some type of public pension benefits to nearly all of their elderly citizens. In most emerging

[6] The benefit ratio is often referred to as the *replacement rate* (pension entitlement as a fraction of preretirement earning).

and developing economies, however, only a third to two-thirds of the elderly are covered, because pension systems were designed to cover salaried workers or those in urban areas, leaving those who are self-employed or in the informal economy outside the system.[7]

Box 1. Taxonomy of Pension Systems

Arrangements. In defined benefit pension schemes, benefits typically depend on the number of years of contributions and ultimate (or average) covered earnings; in defined contribution pension schemes, benefits depend on contribution history and the returns on these contributions. Some countries also offer a flat-rate component that does not depend on previous earnings and that might be means-tested (Australia, Iceland, Indonesia, Malaysia, New Zealand, South Africa).

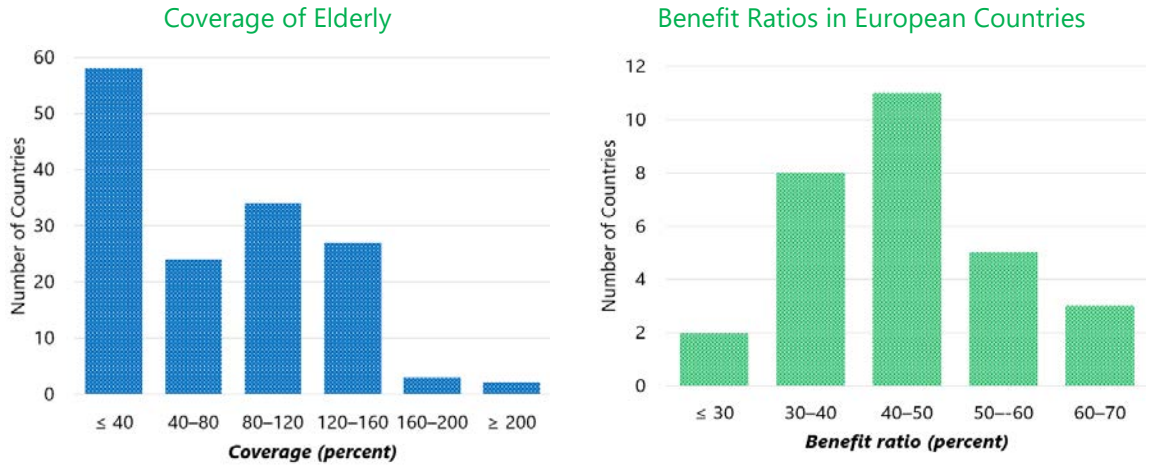
Funding. Another distinguishing feature of pension systems is whether they are pay as you go (PAYG) or fully funded. PAYG systems use current employer and employee contributions to pay for current benefits to the retired. For their long-term sustainability, they depend on the ratio of contributors to pensioners. In funded systems, contributions are invested in assets with the objective of financing future retirement benefits. Most public systems are PAYG, although a few have some degree of private funding (Canada, United States). In contrast, private pensions are typically fully funded. Different arrangements can be funded in different ways. For example, notional defined contribution systems are defined contribution but financed on a PAYG basis (Italy, Sweden) and some defined benefit systems are funded (private defined benefit schemes in the Netherlands and the United Kingdom).

Compliance. Most governments mandate participation in some type of pension scheme, with participation requirements, benefit eligibility, and benefits defined by law. This is the case for most public pensions, but some countries (many in Latin American and Europe) also mandate participation in private schemes. Some schemes are voluntary, typically intended to complement the mandatory schemes, with the choice to participate left to individuals and their employers. This is often the case for private pension systems, such as the 401(K) retirement saving schemes in the United States.

12. Aging and fiscal support for pension systems. Pressures on public saving may arise even in funded systems, because increases in longevity or lower than expected investment returns could cause funding to fall short of providing adequate pension benefits at retirement. Governments might have to make up part of the future shortfall, draining public resources. Fiscal support ratios that relate taxpayers to public pension system beneficiaries are also estimated to rise between 2010 and 2050 in many advanced economies. For European countries, tax revenues would have to be between 14 percent and 28 percent higher than they are today (or expenditures commensurately lower, or some combination of the two) just to offset the increased costs of aging populations (Lee and Mason 2017). For Japan and the United States, the corresponding numbers are 26 percent and 11 percent, respectively.

[7] Pensions have long been an important source of income for the elderly, accounting for more than 60 percent of their income in advanced economies (OECD 2017). Pensions can also help reduce poverty (Shang 2014). Without them, poverty rates among those over 65 would be much higher than those for any other group (Chen and others 2017).

Figure 5. Frequency Distribution of Coverage and Benefit Ratios around the World, 2015



Sources: European Commission 2015 Ageing Report; World Bank Pension Database; and IMF staff calculations.
Note: Coverage of the elderly is defined as the number of old-age pensioners divided by the population 65 years and older. The data are reported for 148 countries. Coverage may be over 100 percent where people can retire before age 65. The benefit ratio is defined as the ratio between the average pension benefit and the economy-wide average wage. These data are reported for 29 countries in Europe.

13. Trade-offs associated with recent pension system reforms. To deal with the costs of aging, many countries have enacted significant pension reforms in recent years. Reforms aim largely at containing the growth in the number of pensioners, typically by changing the key parameters of the pension system; for example, increasing the retirement age, tightening eligibility rules, or reducing the size of pensions by adjusting benefit formulas. Many of these parametric reforms have improved the long-term sustainability of DB/PAYG pension systems. However, additional reforms may be needed; for example, rationalizing generous grandfathering arrangements in earlier reforms (Italy, Portugal); reducing benefit ratios (Argentina, Brazil); and curtailing early retirement benefits (Russia). In many countries, reforms have been designed to protect current pensioners, shifting most of the adjustment burden to future generations of retirees (Chen and others 2017). In some countries, changes in the indexation of pension benefits are likely to erode real pension benefits over time, potentially contributing to old-age poverty (Hernandez de Cos, Jimeno, and Ramos 2017). In the 1990s a number of countries introduced DC systems that were funded by redirecting contributions from existing public PAYG systems. This transition put pressure on public saving, as it worsened the finances of the public scheme. In addition, lack of advance funding, low coverage, and low contribution rates continue to plague many DB and DC systems, with attendant implications for pension adequacy down the road. Because pension savings tend to be concentrated in high-income households for both types of pension systems, rapid aging could also exacerbate income inequality in the future.[8]

[8] Evidence from both advanced and emerging market economies suggests that poor or financially less-literate households save significantly less than wealthier or more financially literate households (see Browning and Lusardi 1996; Dynan, Skinner, and Zeldes 2004; World Bank 2013; Lusardi and Mitchel 2007, 2011; Gandelman 2017).

IMPACT OF DEMOGRAPHIC DEVELOPMENTS ON SAVING

A. Theoretical Underpinnings

14. Model framework. Building on the existing literature, a small open economy overlapping generations model is developed to illustrate the interactions between demographics, pension system design, and saving. A theory of national saving evolves from its components: private and public saving. The model's findings provide guidance for the ensuing empirical analysis (see Annex 2 for a more detailed description).[9] In the model, economic agents live for three periods: (1) as children, (2) as workers, and (3) if they survive into old age, as retirees. The assets of those who do not survive into old age are redistributed to the workers as bequests, capturing within-family intergenerational transfers. Members of the working age population are the only active economic decision makers. They optimally choose their labor supply, consumption, and saving. They also give birth to offspring at an exogenous fertility rate and bear childrearing costs that are proportional to the number of offspring.[10] Economic agents survive into old age and become retirees with an exogenous probability of survival. The two exogenous demographic parameters—life expectancy (longevity) and the fertility rate—jointly determine the old-age dependency ratio. A higher survival probability translates into higher life expectancy at birth. Other than longevity risk, the model abstracts away from uncertainties that could give rise to motives for precautionary saving. The small open economy takes the global interest rate as given.

15. Modeling pension systems. The model features both private pensions and a public PAYG defined benefit scheme that covers all retirees. Workers save to fully fund their private pension benefits, which can be viewed as a DC pension plan. The public pension benefit that a retiree receives is proportional to his or her wage income during the working years. Given universal coverage, the public pension is considered more generous the higher the benefit ratio. The government levies an income tax on labor at an exogenous and constant rate to finance the public pension system, which can be financially unbalanced. The government can thus engage in borrowing or saving, and public saving reacts to changes in demographic trends and pension parameters. A pension deficit reduces public saving, whereas a surplus increases it.

[9] The literature on the effects of demographic changes on national saving has relied primarily on the Auerbach and Kotlikoff (1987) OLG model as an organizing framework (see Carvalho, Ferrero, and Nechio 2016; Boersch-Supan, Ludwig, and Winter 2006). These studies typically do not consider the role of public pension systems. Staveley-O'Carrol and Staveley-O'Carrol (2017) develop an OLG model in which pension characteristics affect private saving. Eugeni (2015) examines the impact of differences in retirement systems across countries using a two-period OLG model. However, these studies do not cover demographics. Most similar in spirit to this discussion note are studies such as Attanasio and others (2016); Barany, Coeurdacier, and Guiband (2016); and Domeji and Floden (2006), in which the impact of demographics on saving and international capital flows are analyzed with pension systems being taken into consideration. However, these studies assume a balanced budget in each period, precluding an analysis of the dynamic behavior of public saving.

[10] Having household saving and consumption decisions explicitly depend on the number of children in the household is a natural way to consider the impact of declining family size on saving rates.

16. Model predictions. This stylized model illustrates the main channels through which demographic developments and public pension systems affect national saving. In particular, it examines the impact on public and private saving of a one-time permanent (steady-state) increase in life expectancy and reduction in fertility rate, as well as changes in pension system generosity.

- *Demographic change and private saving:* A lower fertility rate increases private saving, as households need to spend less on childcare. This effect is partially mitigated by a labor supply response: a smaller fraction of labor income devoted to childcare encourages individuals to work more, thus increasing consumption. In line with theoretical models that capture life-cycle behavior, higher life expectancy at retirement raises private (DC pension) saving of the working age population to finance old-age consumption.[11] However, the impact of a longer lifespan on labor supply depends on a number of offsetting factors (see Annex 2). Both lower fertility and higher life expectancy increase the old-age dependency ratio and thus the share of dissavers relative to savers in the economy. This demographic compositional effect depresses private saving. Thus, the overall impact on private saving depends on which effect dominates.[12]
- *Public pension system generosity and private saving:* Public pension generosity has both a direct and an indirect effect on private saving. Public pension benefits and private saving are substitutes when it comes to providing old-age retirement income: higher pension benefits mean that individuals have to save less to finance consumption in retirement.[13] This result is consistent with both theoretical and empirical findings that countries with PAYG systems tend to have private saving rates that are lower in direct proportion to the generosity of public pension benefits (Eugeni 2015; Samwick 2000; Curtis, Lugauer, and Mark 2017; Rezk, Irace, and Ricca 2009; Bloom and others 2007; Feldstein 1976). There is also an indirect effect. The magnitude of the impact of aging on private saving depends on pension generosity, as demographic variables and pension generosity jointly determine the level of saving. In particular, higher generosity amplifies the positive effect on private saving by the working age population as life expectancy rises. Thus, economies with similar demographic trends can exhibit different private saving behavior owing to differences in pension system characteristics.
- *Public saving:* A reduction in the fertility rate or a higher life expectancy increases the old-age dependency ratio, lowering public saving because public pension expenditure rises relative to tax revenue. The negative impact on public saving is more pronounced in countries with relatively generous public pension systems. Higher pension generosity reduces both public and private saving.

[11] The analysis suggests that the positive effect of higher life expectancy on private saving is attenuated in economies in which within-family intergenerational transfers are an important source of income for the working age population.

[12]The private-saving-to-GDP ratio would also depend on the output impact of demographic changes. While this model suggests that the output effect exactly offsets the compositional effect (see Annex 2), this result does not generalize in alternative model settings.

[13] This result follows from a direct income effect as well as an indirect labor supply effect. The latter stems from the fact that pension benefits in old age are proportional to labor income while working: higher pension generosity induces households to supply more labor. The worker compensates for the disutility of supplying labor by increasing consumption and reducing saving.

- *Changes in the global interest rate:* The model also sheds light on the impact on private saving of changes in the global interest rate. A lower return on assets discourages saving (the substitution effect), but lower future income from savings can induce workers to reduce current consumption, thereby increasing saving (the income effect).[14] The overall impact depends on which effect dominates. In addition to these income and substitution effects, a lower interest rate also reduces the size of bequests relative to the size of the economy. Because bequests are another source of saving in the economy, a lower global interest rate reduces private saving as a share of GDP.

17. Transition dynamics. This analysis does not explicitly capture the transition dynamics of an aging economy or the costs involved in moving from PAYG to funded pension systems.[15] In general, a switch from an unfunded to a funded system would require one generation of workers to pay for two retirements—their own and that of the generation ahead of them—or would require several generations to bear the transition costs. Such a transition could raise national saving by reducing the consumption of the transitional generations, but it would also leave workers in those generations worse off. A study by Boersch-Supan and others (2006) suggests that the saving rate increases during the transition from a PAYG pension system to a partially funded pension system; however, other studies (Aguila 2011; Samwick 2000; Villagomez and Hernandez 2010; World Bank 2006) find the impact of such pension reforms on saving rates to be inconclusive.

18. Additional considerations not captured in this framework. The small open economy setting of this framework simplifies the analysis but precludes an assessment of how demographic changes affect the global interest rate and international capital flows. An extension to the model featuring two countries and unrestricted international capital flows shows that the impact of aging on private saving is dampened by the decrease in the global interest rate, lowering incentives to save. Further, the model does not incorporate financial and labor market imperfections that could affect saving decisions. For instance, private saving could increase with the availability of financial instruments that satisfy the diverse portfolio preference of savers or raise the net return on savings.[16] Financial sector development could also alleviate credit constraints, driving down precautionary saving (Jappelli and Pagano 1994; Bandiera and others 2000). Similarly, labor market conditions (for example, the risk of unemployment) can affect saving decisions, as workers have a stronger motive for precautionary saving when the risk of unemployment is higher (Berloffa and Simmons 2003; Engen and Gruber 2001).[17] The risk of the government defaulting on its pension

[14] The more generous the public pension system, the smaller the income effect. Old-age income consists of gross returns to private savings and public pension benefits, but the income effect from changes in the interest rate only applies to the former. In other words, higher pension benefits translate into a smaller share of old-age income subject to the income effect.

[15] An extension of the model in which demographic variables vary over time shows that the channels identified with the steady-state analysis are also present in the transition dynamics.

[16] Aging itself could influence asset returns and risk aversion; for instance, if risk aversion increases with age, relative demand for safe assets could rise.

[17] Population aging could interact with labor market imperfections and generosity of early retirement provisions, with implications for labor force participation by the elderly (De la Croix and Pestieau 2012). Duval and Bouis (2011) find that early retirement incentives embedded in old-age pension schemes amplify the responsiveness of older workers' labor force participation to economic conditions in OECD countries.

obligations is not explicitly modeled; however, the model does imply that the working age population will save more if this risk becomes more prominent and effective pension generosity declines. With all these limitations, the model nevertheless offers useful insights into how demographics and pension system attributes, and the interaction between the two, affect saving rates, and how these effects can vary across countries.

B. Empirical Estimation of Private Saving

19. Empirical specification for private saving. The model's predictions for the interplay between public saving, demographic variables, pension systems, and private saving are empirically tested using reduced-form cross-country panel regressions (see Annex Table 3.2 for a summary of empirical model specifications used in the literature). Results are presented in Table 1, and a set of robustness checks is discussed in Annex 3. Pension system characteristics are represented by two variables. The first captures whether the pension system is generous, as the theoretical model suggests that saving behavior is different in countries with more generous pension systems. Pension generosity is defined as the product of the benefit ratio and the coverage ratio.[18] This definition encompasses both the size of the benefits an elderly person receives and the number of elderly people covered by the pension system, providing a comprehensive measure of public pension spending (see World Bank 2013). The second variable captures the existence of a DC pension scheme. As suggested by the theoretical model, the presence of a DC scheme should lead to higher private saving. The interaction terms in the specification capture how pension system attributes influence the impact of demographics on private saving. The impacts of credit constraints, labor market conditions, and other macroeconomic variables are included as controls, with the choice of variables informed by the existing theoretical and empirical literature (see Grigoli, Herman, and Schmidt-Hebbel 2014; Loayza, Schmidt-Hebbel, and Serven 2000; Aizenman and others 2017). The baseline empirical approach relies on fixed-effect panel regressions using annual data, covering 75–100 advanced and emerging market economies over the past four decades (see Annex 3 for model specification). Table 1 reports the results of a static regression specification similar to that of Bloom and others 2007; Gutierrez 2007; and Li, Zhang, and Zhang 2007 (see Annex 3 for robustness to alternative estimation methods).

20. Impact of public saving and demographics. Consistent with the predictions from the life-cycle model, there is a negative and statistically significant relationship between the old-age dependency ratio and private saving (columns 1–5 in Table 1).[19] A longer lifespan (proxied by the

[18] Pension generosity is defined as the average pension spending per elderly person divided by GDP per working age population. The regressions include a time-varying dummy variable for high generosity equal to 1 if the generosity is greater than the 75th percentile in the sample and to zero otherwise. Countries identified as having generous public pensions span a wide range of income levels; about half of them are advanced economies.

[19] Some evidence using microdata suggests that households do not typically dissave in old age (for example, Turner and others 1998; Deaton and Paxson 2000). However, Attanasio and Weber (2010) argue that after correcting for cohort effects, the micro evidence is consistent with the life-cycle theory of saving. Saving rates among the elderly may be higher than predicted under the life-cycle hypothesis owing to precautionary saving for late-life events or intended bequests. The distribution of wealth also has a profound effect on saving behavior. With concentration of

expected longevity of a current 40-year-old) is associated with higher private saving, with each year of expected additional life adding about a percentage point to the private saving rate. There is also evidence of a partial, yet substantial, direct offsetting movement in private saving owing to higher public saving, which, in turn, is affected by demographic factors and pension system sustainability.[20] The net impact of a one dollar reduction in public saving is a private saving increase of 60 cents, pointing to the presence of some degree of Ricardian equivalence through intergenerational links. [21] This result is consistent with the view that the perceived sustainability of the public pension system (captured by public saving) is negatively correlated with private saving.

Table 1. Private Saving Panel Regressions

Private Saving	(1)	(2)	(3)	(4)	(5)
Public Saving	-0.52***	-0.53***	-0.53***	-0.59***	-0.59***
Old-age Dependency Ratio	-0.69***	-0.74***	-0.68***	-0.52***	-0.56***
Old-age Dependency Ratio * Pension Generosity		-0.10***		-0.08**	-0.33**
Old-age Dependency Ratio * DC Scheme		0.40*		0.66**	1.16**
Life Expectancy at Age 40	1.03***	0.99***	0.87**	0.98**	1.27***
Life Expectancy at Age 40 * Pension Generosity			-0.05*		0.15**
Life Expectancy at Age 40 * DC Scheme			0.40		-0.61
Employment Rate				0.08	0.07
Real GDP Growth				0.18***	0.19***
GDP per Capita PPP				-0.09	-0.12
Real Interest Rate				-0.07***	-0.07***
Inflation				0.02*	0.02*
Credit to GDP				-0.04***	-0.04***
Terms of Trade				0.03*	0.03*
Observations	3,009	3,009	3,009	1,837	1,837
Number of Countries	80	80	80	74	74
Adjusted R-squared	0.19	0.20	0.20	0.30	0.31

Source: IMF staff calculations.

Note: The table reports results of private saving regression estimated using fixed-effects panel regressions with robust standard errors clustered at the country level. All regressions include a constant term and time dummies. ***, **, * indicate statistical significance at the 1 percent, 5 percent, and 10 percent level, respectively. A list of countries included in the regressions can be found in Annex 3. DC = defined contribution, PPP = purchasing power parity

21. Pension system design matters. The effect of aging (higher old-age dependency ratio or declining working age population) on private saving is mediated by pension system attributes. Higher pension system generosity amplifies the negative effect of a changing age structure (the composition effect) on private saving. Moreover, the impact of aging on saving is mitigated in the

financial assets, drawing down of financial assets may be more pronounced in the lower strata of the wealth distribution, where people may need to rely more on their savings to ensure adequate old-age income.

[20] Some of this offset may also be driven by a demand for safe assets, which has to be met by the government. It further depends on whether the government is forced to run a balanced budget, a constraint that is not imposed in this model.

[21] Other studies point to offsets of private saving in the range of 20–70 cents per dollar of public saving (Aizenman and others 2017). See also Loayza and others (2000), Ferrucci and Miralles (2007), and Roehn (2010).

presence of a DC pension system. Specifically, the results suggest that a 1 percentage point increase in the old-age dependency ratio decreases private saving by 0.5 percentage points in countries without a DC scheme and with nongenerous PAYG/DB public pensions (see column 4 of Table 1). For countries with generous PAYG/DB public pension schemes but no DC scheme, private saving falls by about 0.6 percentage points, as retirees need to rely less on their own savings. However, this effect is reversed in countries with a DC pension system, as such schemes induce employed people to save more for their self-funded retirement. Overall, accounting for pension system design, the results suggest that a 1 percentage point increase in the old-age dependency ratio results in a 0.3 percentage point decrease in the private saving rate. These results hold across specifications and estimation methods.[22] The interaction between longevity and pension system characteristics is less robust (for example, it loses significance in column 5 of Table 1 for the presence of a DC scheme), as the effects of generosity and the presence of DC schemes are likely captured by their interaction with the old-age dependency ratio.

22. Caveats. Caution is advised in drawing definitive policy implications from cross-country regression analysis, as different pension system policies are likely to have varying effects across countries and at different points in time. Moreover, pension system characteristics are multidimensional by nature, and measurement limitations (for example, coverage, retirement incentives, replacement rates in public PAYG and funded systems) must be considered in comparing these dimensions. Reverse causality and nonlinear relationships between some covariates and the private saving components are also possible.[23] However, even when the structural relationship linking these variables is unlikely to be fully captured and there is limited focus on transition dynamics, the exercise can still be used to examine the outlook for private saving.

C. Saving Projections

23. Future of saving. How will forthcoming demographic changes affect private saving and public finances, and thus national saving, through 2050? To address this question, the analysis addresses the impact of demographic changes and pension characteristics on public and private saving. The first step is to estimate the effect of expected demographic developments and enacted pension reforms on public pension system outlays, relying on the authorities' projections for future pension spending, which incorporate assumptions about reforms adopted to date (including changes that will take effect in the future).[24] It is assumed that the projected increase in public

[22] Although the interaction coefficient of generosity with life expectancy is negative in column 3 of Table 1, it is positive in column 5. Yet the net effect of generosity, including the interaction with both life expectancy and the old-age dependency ratio, is significantly negative in both specifications.

[23] Examining private saving from a microeconomic perspective can provide a more realistic and nuanced view of the likely evolution of saving, better capturing cohort-specific and distributional effects but at the cost of considering a more limited set of countries given the data constraints. For instance, cohort analysis could help disentangle whether saving has been rising in some countries because the share of the population in the high-saving ages has increased or because younger cohorts have been saving more.

[24] To ensure comparability across countries, initial pension expenditure is set equal to the latest OECD estimates of public pension spending across OECD countries and to the latest International Labour Organization estimates for other countries. The projections for pension spending as a share of GDP reflect available official estimates through 2050. For European countries, these are based on the European Commission 2015 Aging Report. For other advanced

pension spending translates fully into lower public saving. This impact can be viewed as a lower bound of the effects of demographic change, as other aging-related spending—health expenditure in particular—is assumed not to increase (see Box 2). Second, model coefficients from the empirical analysis (column 4 of Table 1) 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 saving (owing to changes in public pension spending)[25]. Demographic variables are assumed to evolve in line with the United Nations medium-fertility variant scenario, while all other determinants are held constant. The analysis supports exploratory inferences about how differences in countries' progression along the demographic transition will affect their saving profiles in the coming decades, given their pension system attributes.

Box 2. Health Care and Saving

Health care costs constitute an important channel through which demographic changes can affect both private and public saving. As with pensions, the impact of demographic changes on saving depends on the characteristics of health care systems, including the generosity, coverage, and quality of public health care programs and the extent of participation in private health insurance. Health care costs tend to follow a life-cycle pattern: average per capita costs tend to be higher in early years, drop during adolescence, and increase progressively beginning in the mid-forties. Thus, the projected increase in the relative number of elderly people is expected to push up health care spending. Aging-related pressures on overall saving grow with higher longevity, as needs for precautionary saving in response to uncertainties regarding medical expenditure and long-term care rise disproportionately with higher old-age life expectancy and incomes (De Nardi, French, and Jones 2009).

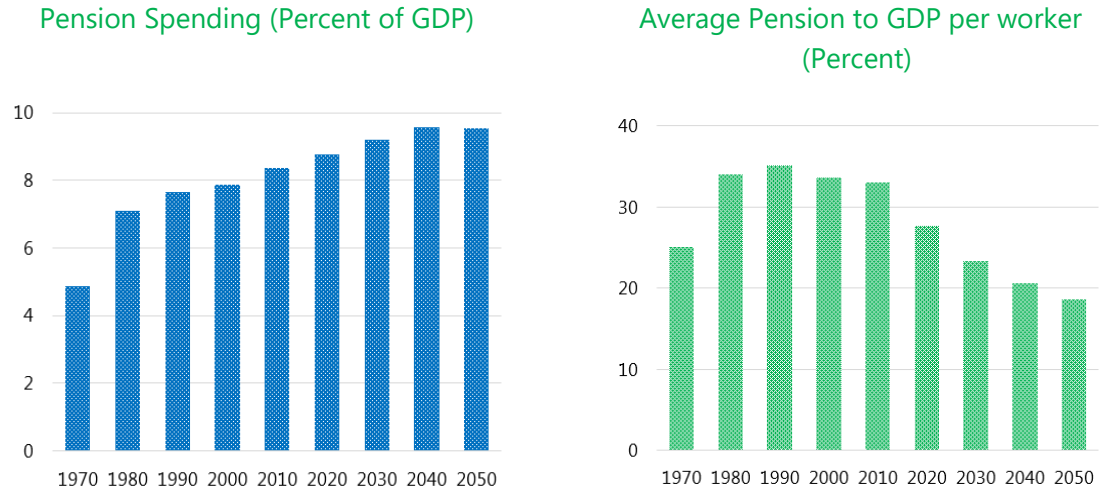
Health care costs are also affected by nondemographic factors, including the adoption of new technologies and the relatively lower productivity increases in services relative to other sectors of the economy (Baumol 2012). This renders projections of health care spending subject to more error than projections of pension expenditure. For instance, prices of medical services and medicines are determined in part by market conditions, and technological innovations not only affect processes but also make new treatments available. Thus, any projections of health care spending have a high degree of uncertainty, even assuming an unchanged policy environment.

economies (for example, Australia, Canada, Japan, Korea, and the United States) and a few emerging market economies (for example, Brazil and India), the projections come from national authorities' actuarial reports for the main pension system forecasts. For other emerging market economies (including Chile, China, Colombia, Egypt, Mexico, Turkey, Russia, and Ukraine), the projections reflect IMF staff estimates, accounting for reforms enacted to date. For the projections, the old-age dependency ratio was permitted to change in line with projected demographic developments, holding all other factors constant.

[25] See Annex 3 for the model's in-sample predictions. Annex Table 3.3 has the full list of countries.

24. Declining public saving. Demographic developments will drive up pension costs, putting public saving on a long-term downward trend globally. Worldwide, public pension spending pressures could depress public saving by just over 2 percentage points of GDP by 2050, with significant differences across countries.[26] Reflecting recently enacted reforms, public saving in most advanced economies could fall modestly (by about 1 percent of GDP) between now and 2050 (Figure 6). For instance, in rapidly aging Germany, past reforms to curtail generosity and increase retirement age are projected to contain pension spending increases to slightly over 2 percentage points of GDP by 2050. In contrast, the United States has undertaken less significant reforms but has a relatively younger population and higher population growth. Hence, population aging is more gradual, resulting in a projected increase in pension spending of 1.6 percentage points of GDP by 2050 (Figure 7). Overall, in advanced economies, the projected spending on public pensions under current policies implies significant future reductions in the average pension (Figure 6). In other words, implicit or explicit commitments on generosity can be kept only if public pension spending increases beyond authorities' current projections. The projected decline in public saving is larger for emerging markets and developing economies, and particularly pronounced for countries experiencing rapid aging and those in which pensions have yet to be reformed.[27] For instance, in Brazil and China, pension expenditure is projected to increase by 7 and 6 percentage points of GDP, respectively, by 2050.

Figure 6. Projected Pension Spending and Generosity in Advanced Economies, 1970–2050

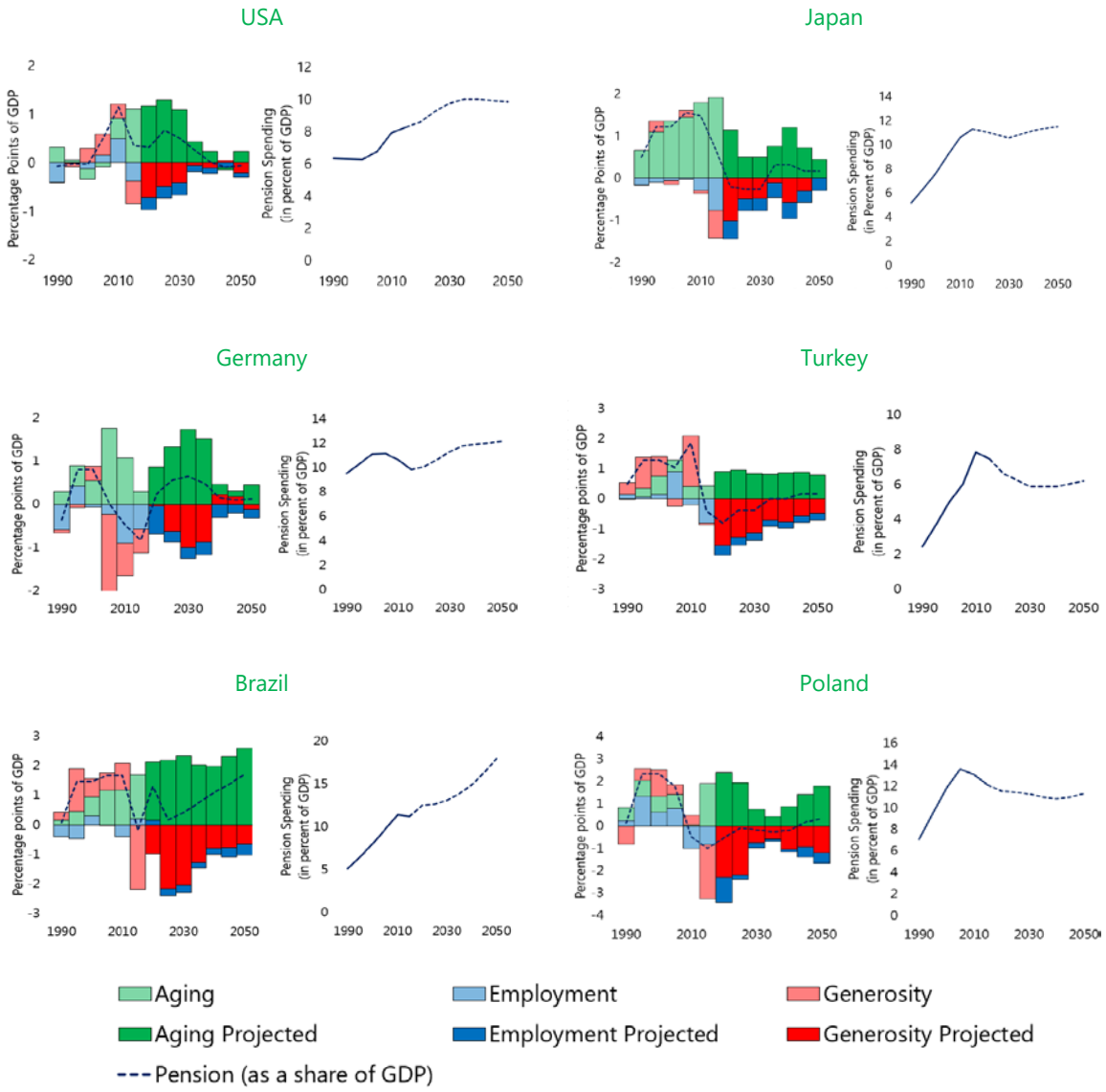


Sources: Eurostat; OECD (2017); and IMF staff calculations.
Note: Average pension-to-GDP per worker can be viewed as a proxy for the benefit ratio (the average pension divided by the average preretirement earning). They both measure the extent to which an individual's pension adequately substitutes for his or her preretirement earnings. As GDP per worker is higher than average preretirement income, average pension-to-GDP per worker is lower than benefit ratios. Data after 2010 are projections.

[26] This should be viewed as a lower bound, as health-related spending is projected to surge, by 3.8 and 2.3 percentage points of GDP in advanced and emerging and developing economies, respectively, over this period (Clements and others 2015).

[27] This calculation may understate the potential burden on public expenditures, because rising incomes in many emerging and developing economies could result in demands for higher benefits and more widespread coverage in countries in which the public sector provides only limited pensions.

Figure 7. Contribution to Pension Change, 1990–2050, Select Countries



Sources: Country authorities' pension spending projections; and IMF staff calculations.
Note: Generosity is defined as the product of public spending per pensioner as a ratio of the average GDP per worker and pension coverage (number of pensioners as a fraction of the population 65 years and older). Employment measures the fraction of the population of working age that is employed. Aging is captured by the old-age dependency ratio, which measures the number of elderly people in relation to the working age population. Projections for Poland do not include the decrease in retirement age since October 2017.

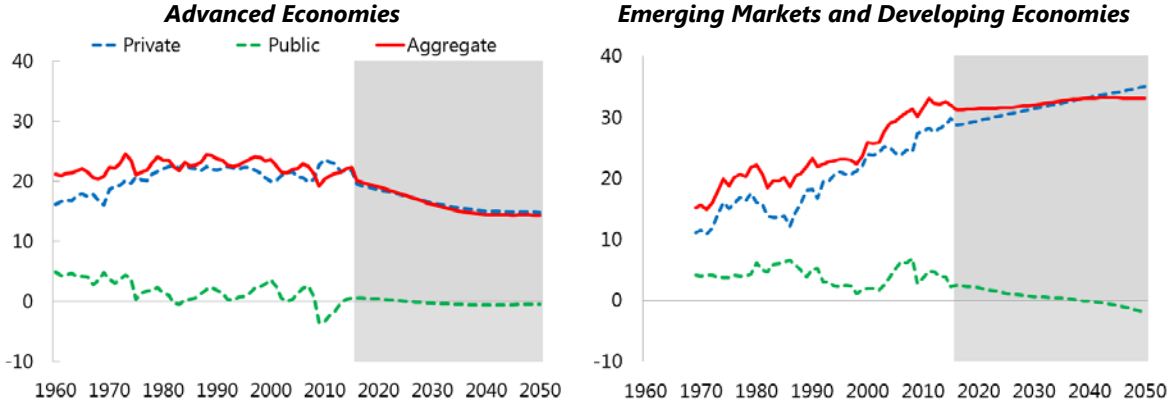
25. Evolution of private and aggregate saving. The evolution of private and national saving depends on the interaction of demographic developments with pension system attributes. Assuming unchanged country weights, global saving could potentially decline by about 3 percentage points of GDP between now and 2050.[28] In emerging markets and developing countries collectively, higher private saving by relatively younger populations offsets the projected decline in public saving,

[28] The decline in the overall global saving rate could turn out to be more moderate than projected, as the projections are based on current country weights in global GDP. If the rising share of global GDP of the relatively higher-saving emerging and developing countries in the coming decades is accounted for, average global saving rates would decline by less.

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 (Figure 8). These aggregates mask substantial heterogeneity across countries, driven by differences in demographics and pension system design.

Figure 8. Saving Projections by Country Groups

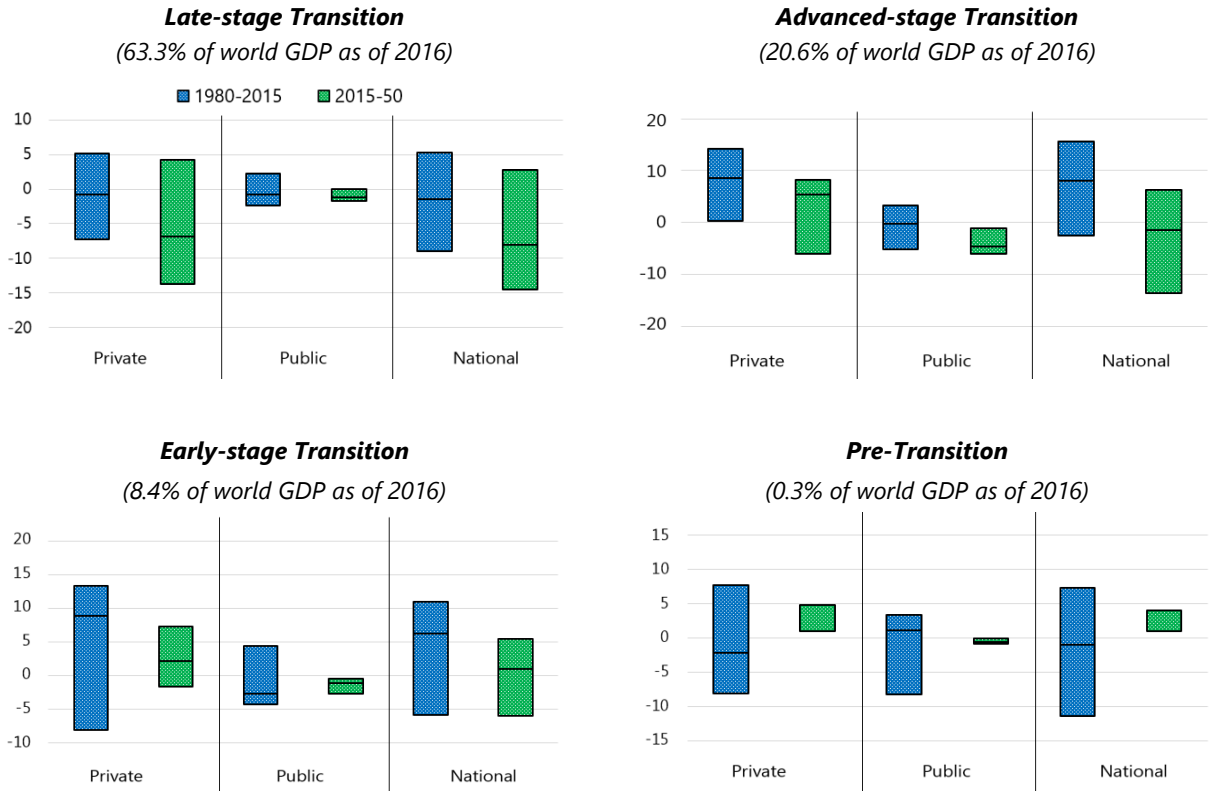
(Percent of GDP, averages)



Sources: IMF World Economic Outlook; and IMF staff calculations.
Note: Projections in 2016 and later years include data for 74 countries that accounted for over 80 percent of world GDP in 2016.

26. Saving rate heterogeneity: stage in demographic transition. Differences in the timing of the demographic transition play a role in influencing saving dynamics across countries (Figure 9). In *late-stage transition countries*, private saving is projected to fall significantly as older age groups (which have high dissaving) make up an increasing share of the total population. Together with lower public saving, this translates into a sharp projected decline in national saving by over 4 percentage points of GDP, on average, between now and 2050. In contrast, national saving among countries in the *advanced demographic transition stage* is projected to remain broadly stable, as higher private saving offsets public dissaving. However, large disparities in saving rates underlie this average. Saving in many countries in Latin America and the Caribbean that will experience rapid aging has hovered below 20 percent of GDP in recent decades. In contrast, China is notable for its high saving rate over the past 35 years (Box 3). Countries in the *early transition stage* will see the bonus from a growing working age population and declining family sizes fade, moderating the increase in private and aggregate saving observed in the recent past. In *pretransition countries*, both public and private saving are projected to increase significantly given their relatively young and rapidly growing populations.

Figure 9. Changes in Saving Rates by Demographic Transition Stage
(Percentage point change)



Source: IMF staff calculations.
Note: The box denotes the 25–75 interquartile range as well as the weighted average. World GDP is calculated as the sum of the US dollar values of the countries. Changes between 1980 and 2015 represent actual data; changes between 2015 and 2050 are based on projections.

27. Saving rate heterogeneity: role of pension system characteristics. Within the demographic groupings above, 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 some countries (Figure 10, left). In contrast, private saving is expected to decrease by about 6 percentage points of GDP in countries with PAYG pension schemes, as the system itself does not encourage higher wealth-holding by individuals. This, in combination with higher age-related public pension spending, will lead to a substantial decline in national saving (Figure 10, right). In general, benefit generosity pushes up pension spending while weighing down public saving. Private saving falls somewhat 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 (Figure 11, left). 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 (Figure 11, right).

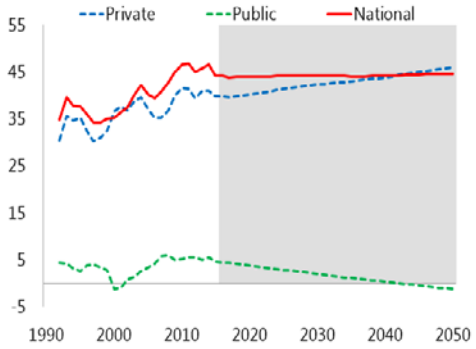
Box 3. Saving Trends in China

Saving trends in China have received considerable attention. China has one of the highest national saving rates in the world, exceeding 40 percent of GDP since 2000 and peaking at 52 percent of GDP in 2008, with a gradual decline thereafter. Several studies have identified precautionary motives as important drivers of this trend (Chamon and Prasad 2010; Zhang 2017). A weak social safety net, including limited pension system coverage, encourages households to save to be able to deal with adverse events through private means. Although reforms introduced in recent years have led to an increase in pension outlays, pension generosity remains relatively low. Other factors that contribute to high household saving include rapid economic growth, a growing share of the working age population, and tight credit constraints (World Bank 2013).

Population aging will lead to a reduction in China's saving in the future. However, the interaction of aging with pension system characteristics suggests that the decline in aggregate saving may be less pronounced than aging alone would suggest. China is in the advanced stage of demographic transition, with a rapidly aging population structure owing to much lower fertility than other countries at a similar stage of economic development. The old-age dependency ratio is expected to more than triple between 2015 and 2050 from the current level of 13 percent, exerting downward pressure on both public and private saving. Still, assuming unchanged policies, low pension generosity, and the presence of a defined contribution system, the model suggests that national saving will broadly hold steady rather than decrease over the projection horizon.

Figure 3.1 Saving Projections for China

(Percent of GDP, averages)



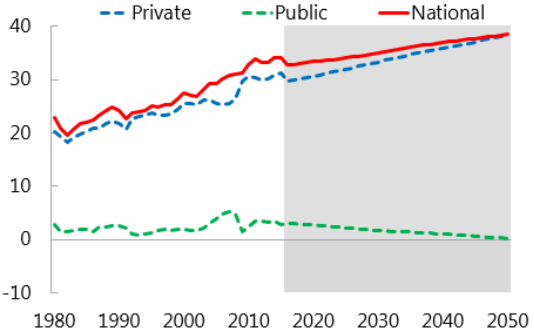
Source: IMF staff calculations.

Policy efforts and behavioral changes could lead to a further reduction in saving (IMF 2017). As detailed in Zhang (2017), strengthening the social safety net and changing consumption behavior of younger generations will likely decrease the national saving rate by about 4 percentage points by 2022.

Figure 10. Saving Projections by Type of Pension System

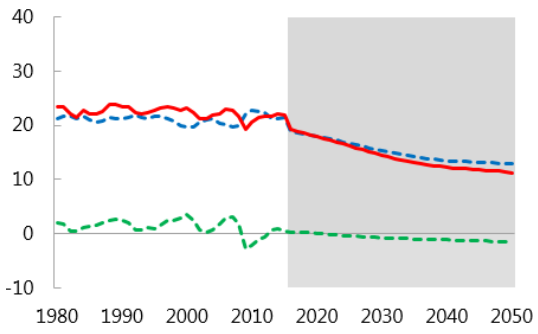
With DC Scheme

(32.39% of world GDP as of 2016)



Without DC Scheme

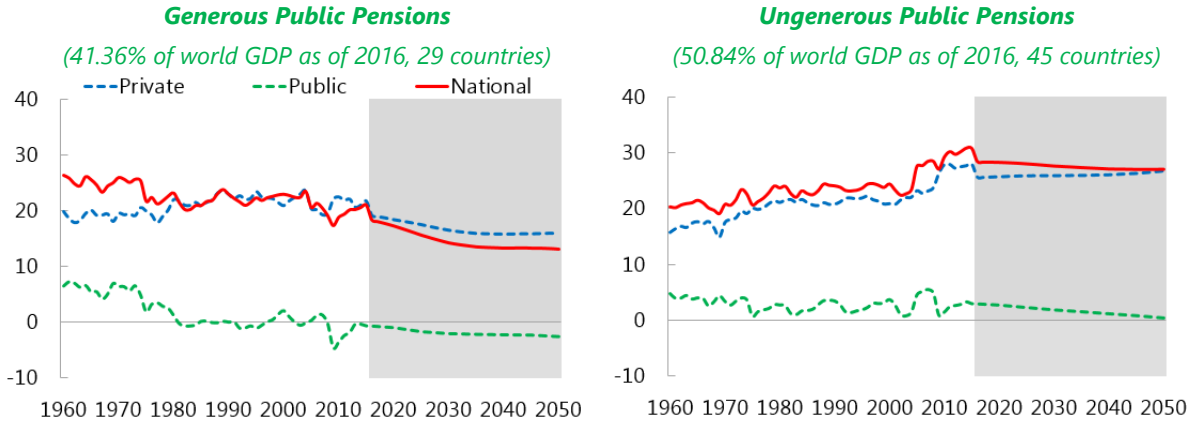
(59.81% of world GDP as of 2016)



Source: IMF staff calculations.

Note: World GDP is calculated as the sum of the US dollar values of the countries. DC=defined contribution.

Figure 11. Saving Projections by Pension System Generosity



Source: IMF staff calculations.
Note: World GDP is calculated as the sum of the US dollar values of the countries. The generosity grouping is taken for the year 2015.

28. Individual country trends. The importance of pension system design for saving is clear when countries with similar demographic patterns but different pension system characteristics are compared (Figure 12). Take Tajikistan and Pakistan, two countries in the early stage of demographic transition. The pension system in Tajikistan features a DC scheme; that in Pakistan does not. This difference in pension system design leads to significant differences in the evolution of saving: between now and 2050, aggregate saving rates are projected to increase by 2 percentage points of GDP in Tajikistan and to decline by about 2½ percentage points of GDP in Pakistan. Another example is Russia and Australia, two countries in the late demographic transition stage.[29] Both countries have a DC system, but pensions in Russia are more generous relative to national income than those in Australia. As a consequence, aggregate saving in Australia is expected to increase at a much faster pace than in Russia. Projections for China and Korea also suggest that low pension generosity drives up precautionary private saving.

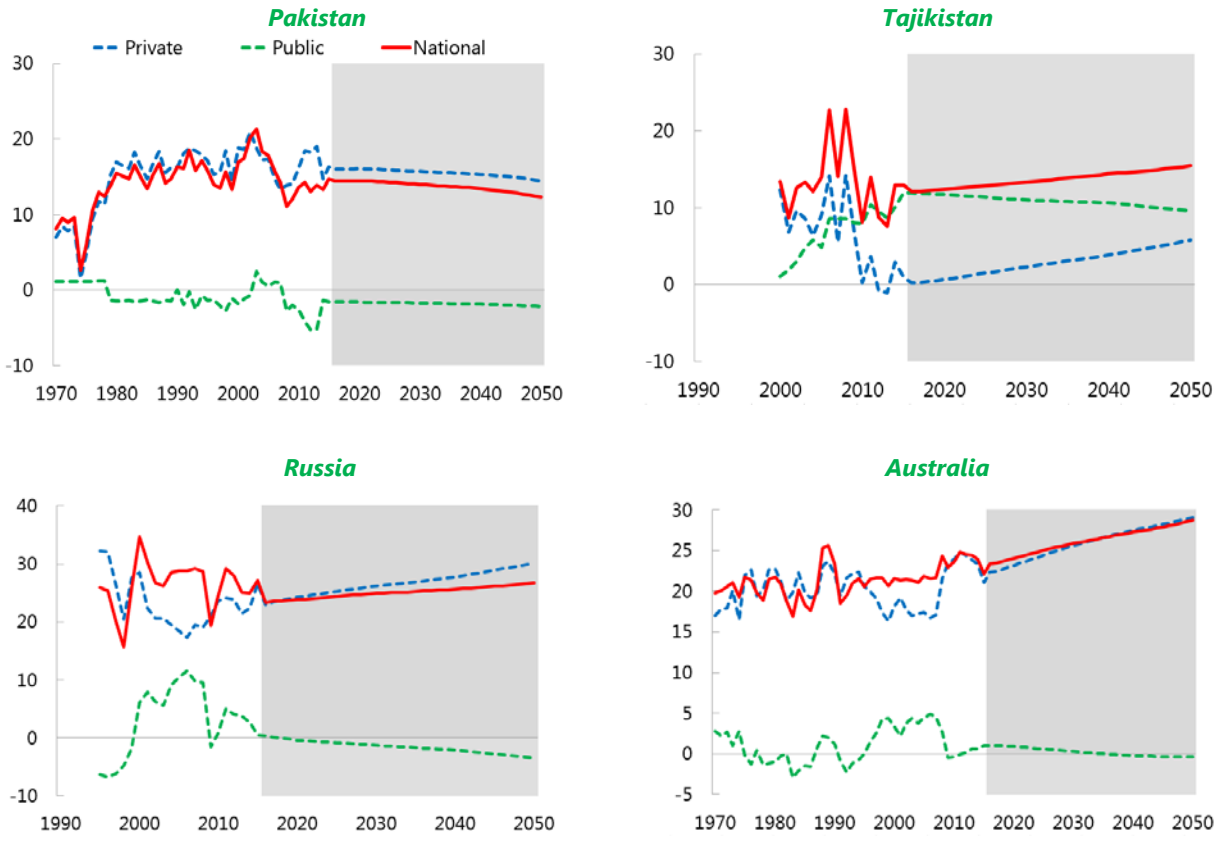
29. Illustrative projections. While this framework provides simple inferences on the evolution of public and private saving across different countries under a no-policy-change scenario, several considerations apply. First, the framework is based on partial equilibrium analysis and abstracts from behavioral and policy changes and price effects. For instance, the evolution of government saving patterns in the future could depend on other factors that moderate the fiscal impact of aging, such as tax and labor market reform and changes in non-age-related spending. Second, relationships observed in the past between aging and private saving (that is, the estimated regression coefficients) may not be good predictors of the future. In addition, cohort effects may be important in shifting profiles of saving at different ages; for example, in the future, middle-aged people might

[29] Owing to relatively high immigration, the median age in Australia is notably lower than that in many other countries in the late demographic stage.

increase their saving in response to longer lifespans.[30] Third, the analysis of the effects of demographic changes on saving through the prism of pension systems could be further refined; for example, by using more granular data on replacement rates or accounting for pension system assets. Finally, changes in saving rates would be driven by long-term trajectories of productivity growth, but demographic changes could depress productivity and growth prospects, lowering the rate of return on savings. Given these considerations and the substantial uncertainty surrounding demographic projections, the projections in this discussion note should be viewed as illustrative and are not intended as forecasts.[31]

Figure 12. Saving Projections for Individual Countries

(Percent of GDP, averages)



Source: IMF staff calculations.

[30] Moreover, the failure of households, which ultimately own domestic corporations, to see through the "corporate veil" suggests that disentangling the impact of aging on household and corporate saving could be relevant.

[31] Indeed, past demographic projections have been subject to significant errors (see Clements and others 2015 and future realizations of fertility, mortality, and migration might differ substantially from the projected levels.

CONCLUSIONS AND POLICY OPTIONS

30. Aging challenge and saving. Aging populations will have important consequences for the evolution of saving rates across countries. Under current policies, public pension outlays in advanced and emerging market economies will increase by an average of 1 to 2½ percentage points of GDP, respectively, by 2050, depressing public saving. The impact on private and aggregate saving depends on the interaction of asynchronous demographic transitions and the design of retirement systems; that is, funding, coverage, benefits promised to the elderly, and when they would start receiving those transfers. Thus, the appropriate responses to the aging challenge will vary across countries and will have to account for country-specific policy and institutional settings, including how pensions are determined and financed. For instance, in countries with relatively high saving rates and inadequate social security systems, increasing generosity may be warranted. In rapidly aging countries with relatively low saving rates and rising pension liabilities, the challenge will be to increase saving ratios in a sustainable way. For today's younger generations in many countries, saving more for the future will become increasingly important to ensure retirement income security.

31. Public pension system reforms. Overly generous pension benefits (owing to high benefit ratios or a low statutory retirement age) can interact with projected demographic trends to lower aggregate saving. Reducing public pension generosity (for example, curtailing early retirement benefits or reducing benefit ratios) could attenuate long-term fiscal vulnerabilities and moderate the fall in aggregate saving. To counter these trends, today's workers will need to prepare for the future by saving more and extending their work lives. In advanced economies where pensions have been largely reformed, for those born between 1990 and 2009, simulations suggest that increasing the retirement age by five years (from today's average of 63 to 68 in 2050) would close half the projected gap in benefit ratios relative to today's retirees. If members of the same cohort were to put aside an additional 6 percent of their earnings each year, they would close the other half of the gap in the benefit ratio. Financial sector and labor market policies could support such behavioral changes.

32. Balancing sustainability and equity considerations. The distributional consequences of pension system reform can be significant. While ongoing and planned reforms will improve pension system sustainability, average benefit ratios are projected to decline sharply in many countries. Thus, additional pension system reforms would need to be carefully calibrated to avoid undercutting the welfare of future retirees and fueling poverty among the elderly. One option would be to link additional increases in retirement age to longevity gains, with adequate provisions for the poor, whose life expectancy tends to be shorter than average. To minimize unintended negative consequences of such programs on aggregate saving (either through excessive fiscal costs or indirectly by crowding out private saving), antipoverty programs should be carefully designed and targeted.

33. Improving pension system adequacy to reduce precautionary saving. In China, for instance, the transition to a market-based economy that began in the 1980s resulted in a weakening of the social safety net, reducing pension spending and social transfers to very low levels. Lower-

income households now have a saving rate of 20–30 percent, compared with minus 20 percent in many peer countries (IMF 2017). Similarly, in Korea, the public pension system covers only about a third of the elderly, and replacement rates are low by international comparison, resulting in a saving rate of nearly 30 percent. These countries have room for fiscal maneuver; they could redirect resources to reduce old-age poverty by expanding coverage of the social security systems, raising social pensions, and enhancing targeted social transfers. These actions would reduce households' need for precautionary saving while ameliorating inequality and old-age poverty.

34. Boosting private saving by improving pension system architecture. The presence of a DC scheme can support higher private saving rates, attenuating the negative effect of aging on national saving. Countries with an enabling environment might consider complementing the public pension scheme with a funded DC scheme.[32] However, such reforms are not a panacea to deal with the aging challenge; for example, too few people may be covered or contribute to the system, or contributions over the working life of an individual may fall short of providing adequate pension benefits at retirement—many private pension funds are underfunded.[33] In addition, future returns on savings (interest and investment rates) in an aging world could be lower, leading to lower-than-expected returns on the accumulated assets in such systems. In this case, governments might still have to make up for at least part of the gap. Country experiences also suggest that pension system transitions from PAYG to funded schemes can generate large and persistent fiscal costs (to fulfill the promises made to people who had contributed to the old systems) that reduce national saving.

35. Development of financial sector instruments to encourage voluntary saving. The ability of households to diversify retirement-related risks will depend on the availability of age-specific financial products (for example, annuities and long-term care insurance). Countries with underdeveloped financial sectors would benefit from boosting financial inclusion (for example, efforts to reduce the costs of bank account for individuals) and creating sound and resilient banking sectors that offer the right mix of long-term saving instruments. Financial literacy could foster a culture of saving and help people better plan for retirement. And government policies could focus on increasing voluntary private saving; for example, by providing tax-preferred saving vehicles related to pensions, such as the 401(K) plans in the United States. Tax-preferred general or education saving accounts could also be considered, but participation of middle-income households would be essential for these schemes to generate additional saving rather than displacing existing saving elsewhere (OECD 2007). Nudges to encouraging workers to save can also help; for example, by automatically enrolling them in pension schemes, as in the United Kingdom.

[32] The enabling environment requires the existence of some important preconditions. First, macroeconomic stability needs to be secured to enable the development of long-term capital market instruments. Second, a sound financial sector and infrastructure, including legal and regulatory infrastructure and adequate supervisory capacity, needs to be in place to allow for the proper management of pension savings. Third, proper collateralization and bankruptcy procedures, creditor and property rights, accounting regulations, and adequate payment system are all necessary to ensure the credibility in the funded scheme.

[33] The average ratio of underfunded pension liabilities to annual revenues remained at about 6 percent from 2011 through 2016 (Grunfeld 2017, using 5,100 global public companies). Moreover, there are concerns that the extent of underfunding might be understated because of the use of accounting rules that help reduce the size of estimated liabilities (for example, Kisser, Kiff, and Soto 2017).

36. Counteracting the effect of aging on labor supply. On current demographic trends, many countries will face a declining labor force, which will drive down saving. Policies should focus on reforms that close gender gaps in labor force participation (as was done in Italy and Spain) and encourage people to lengthen their productive work lives, given their increased longevity. Policy actions could include ensuring equal remuneration for equal work and providing childcare services. Governments can make it easier for older people to remain in the workforce by reconsidering taxes and benefits that favor early retirement. Migration could also play a role in boosting the labor force in many advanced economies, but this is a politically contentious issue. In many emerging market economies, it is important to decrease the large share of young people who are neither participating in the labor market nor studying. Furthermore, reducing the large share of the labor force that does not work in the formal sector—and thus does not pay taxes or contribute to social security—could boost saving. Education and training policies could use some modifications to better align skills with rapid technological change, which will replace labor in some sectors but may be labor-augmenting in others (Manyika and others, 2017). Private (and to some extent public) saving will play a key role in helping individuals cope with these trends and changes.

ANNEX 1. Current State of Demographic Transition

The current trends in fertility and mortality rates result in geographically asynchronous demographic transitions. Mortality rates have been declining in all countries, but for different reasons. More advanced economies have long enjoyed low child mortality rates, but in less-developed parts of the world, the drop in child mortality has been a more recent phenomenon and has contributed to higher population growth rates. In advanced economies, improvements in health care have led to lower mortality rates among the elderly, which has resulted in an increase in longevity and lower overall mortality rates. Average worldwide fertility rates have declined precipitously from nearly five births per woman in the 1950s to half that in 2015. As a result, the gap between highest and lowest fertility regions has narrowed.

In this study the countries are ordered by their state of demographic transition. Following IMF 2015b, the *k*-means clustering method is used to create four groups of countries: late-stage transition or posttransition, advanced stage, early stage, and pretransition. The cluster analysis takes into account current population growth and age composition, as well as measures capturing the time profile of the transition. Specifically, it uses the following variables: (1) average annual population growth (excluding migration) between 2010 and 2016; (2) child and old-age dependency ratios between 2010 and 2016; and (3) the number of years before or after the minimum total dependency ratio is reached (indicating whether the first demographic dividend has yet to appear or has already started to dissipate).

Four groups of countries are identified according to their current stage of demographic transition (Annex Figure 1.1):

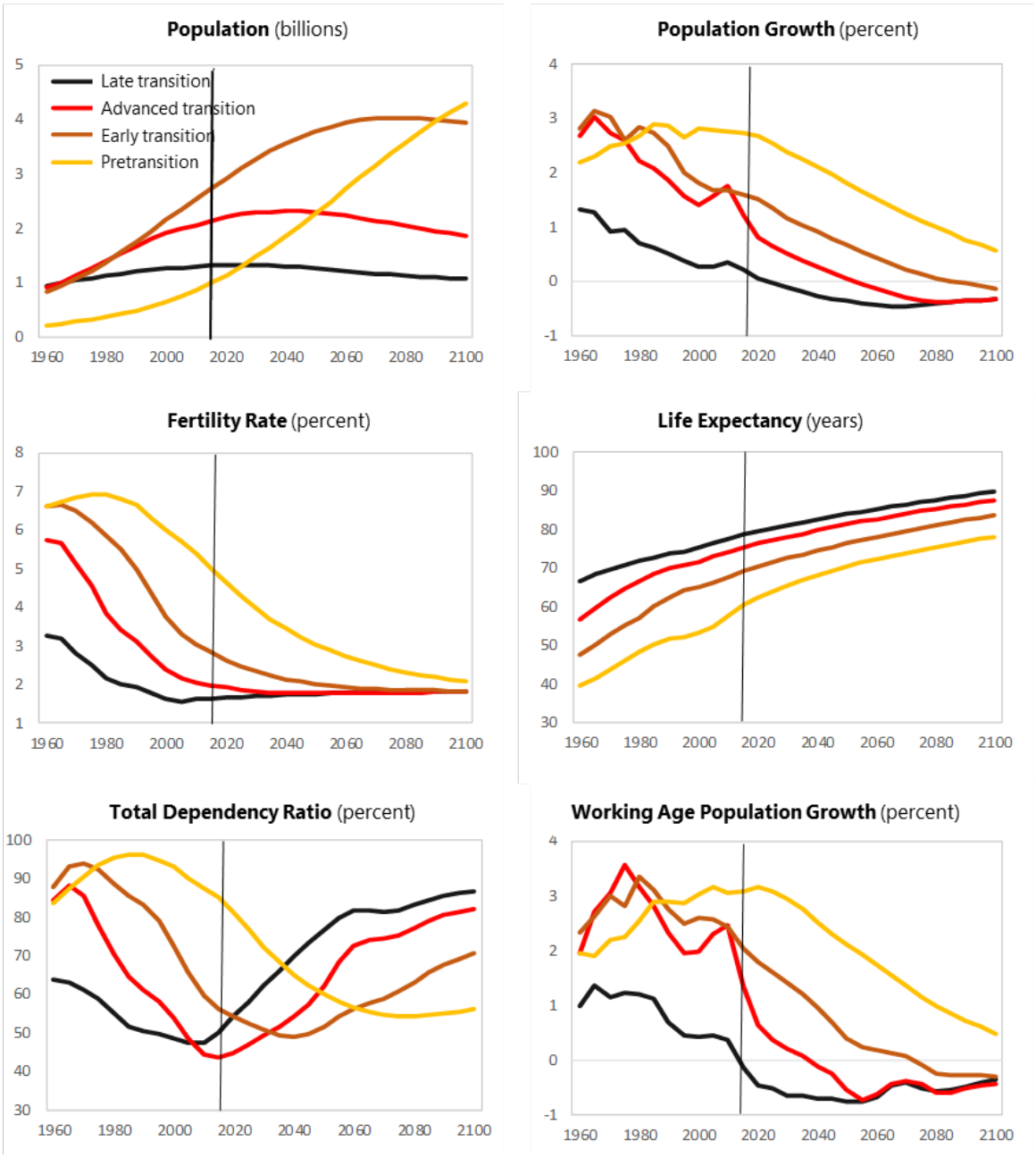
- *Late-stage transition or posttransition countries:* Countries experiencing decelerating population growth or a declining population, with the resulting increase in old-age dependency ratios. Most advanced economies and a few emerging market countries are in this category.

- *Advanced-stage transition countries:* Countries in which, after peaking in the early 2000s, a relatively rapid transition is taking place from a high child dependence state to a high old-age dependence state. Many emerging market economies in Asia (for example, China) and Latin America (for example, Argentina and Brazil) are in this group.

- *Early-stage transition countries:* Countries that have started to experience a decline in fertility rates, but in which fertility rates are still relatively high. The share of working age population is expected to peak in the first half of the 21st century, so these countries are still benefiting from the demographic dividend. This group encompasses several low-income developing and emerging market economies in Asia, Latin America, and the Middle East and North Africa region.

- *Pretransition countries:* Countries in which fertility rates remain at a high level while mortality rates decline. Persistently high fertility leads to rapid population growth and a series of sizable youth cohorts. Many low-income developing countries, mostly in sub-Saharan Africa, are in this category.

Annex Figure 1.1. Demographic Indicators across Country Groups



Sources: UN 2015; and IMF staff calculations.

ANNEX 2. A Small Open Economy Overlapping Generations Model: Demographics, Pension, and Saving

A small open economy overlapping generations model is developed to study the effects of demographic change on private and public saving, highlighting the role of public pension system design. The small open economy setting ensures analytical tractability and allows for an extension to a two-country framework (see Chai and Kim 2018 for details). The model features a public pay-as-you-go (PAYG) pension scheme, the most common form of public pension system. The pension system is allowed to be financially unbalanced; the government can engage in borrowing and lending so that public saving reacts to changes in demographic trends and pension parameters. The model also features endogenous labor supply to allow labor supply of the working young to vary in response to demographic and pension parameter changes, which could affect saving decisions.

The model framework allows for permanent one-time shocks to longevity and fertility, and explores the impact of these demographic changes on public and private saving. In reality, demographic changes are gradual shifts rather than sudden shocks, so the simplified analysis here does not capture the transition dynamics of an aging economy; however, it offers useful insights into long-range changes in saving rates and enables the comparison of saving rates across economies with different demographic trends.

Theoretical studies on demographics and saving (for example, Brooks 2003) typically focus on private saving and ignore public pensions or saving in the public sector. This model shows that public pension schemes matter for both private and public saving rates. Recent literature (for example, Staveley-O'Carrol and Staveley-O'Carrol 2017 and Eugeni 2015) develops models in which pension characteristics affect private saving. However, these papers typically either do not study demographics or assume a fiscally balanced public pension system, precluding an analysis of public saving. Most similar in spirit to this model, Attanasio and others (2016) developed a quantitative, multiregion model with a public PAYG pension system and used it to study the effects of demographic change on consumption, saving, and international capital flows. While the model presented here is more parsimonious, it captures the same primary forces. It also allows for endogenous labor supply decisions, providing an additional channel through which changing demographics can affect private and public saving.

Production

Production is given by standard Cobb-Douglas function, where *K* denotes *e* capital and *L*, labor:

$$Y_t = K_t^{\alpha}(A_t L_t)^{1-\alpha}$$

Capital freely moves across borders, while labor supply is assumed to be endogenous.

Demographics

Agents live for at most three periods: children, young working age (*y*), and old (*o*). The young give birth to offspring at a fixed rate, g, and survive into old age with constant probability χ. Life expectancy at birth is therefore $1 + \chi$. It is straightforward to show that the old-age dependency

ratio is χ/g, increasing with longevity and decreasing with fertility. The population growth rate is equal to the fertility rate. Retirees consume all their private pension savings and public pension benefits in one period.

Young agents' problem

At time t, a representative young agent supplies labor l_t at the wage rate w_t, and pays labor income tax at rate τ as well as childcare costs η as a share of income per child. The latter assumption captures the fact that childcare costs are generally positively correlated with the income level. The young also save a_{t+1} in a competitive private pension fund at a rate of gross return R^*. Old people do not work and live off both private and public pension payments. The public pension payment is a fraction ϕ of the old people's labor income when young; that is, $b_{t+1} = \phi w_t l_t$. If a young person does not survive into old age, his or her assets are distributed as unintentional bequests evenly among the working age population. The young's optimization problem is therefore:

$$\max_{a_{t+1}, l_t^y} u\left(c_t^y, l_t\right) + \beta\chi u(c_{t+1}^o, 0)$$

$$\text{s.t. } c_t^y = (1 - \tau - g\eta)w_t l_t + v_t - a_{t+1}$$
$$c_{t+1}^o = R^* a_{t+1} + \phi w_t l_t.$$

The bequest, v_t, is given by:

$$v_t = \frac{(1-\chi)R^* a_t}{g}.$$

The utility function is assumed to take the following form:

$$u(c, l) = \log\left(c - \frac{\theta}{1+\varepsilon} l^{1+\varepsilon}\right),$$

which is a special case of the Greenwood-Hercowitz-Huffman utility function, with the intertemporal elasticity of substitution being unity. The Greenwood-Hercowitz-Huffman formulation abstracts from wealth effects on labor supply. These preferences are widely used in the literature, as they allow quantitative models to produce reasonably sized fluctuations in labor supply in the absence of either nominal price rigidities or labor market frictions. Solving the maximization problem reveals that labor supply is given by:

$$l_t = \left[\left(\frac{\phi}{R^*} + 1 - \tau - g\eta\right)\frac{w_t}{\theta}\right]^{1/\varepsilon}.$$

Labor supply is increasing in the wage rate and pension generosity (the substitution effect). Note that there is no wealth effect given the way labor enters the utility function; therefore, the substitution effect dominates. The wage rate is constant in equilibrium. Higher life expectancy does not induce the young to supply more labor even though it increases the expected payoff of pension benefits. The reason is that the young would choose to suppress consumption to save more for retirement, raising the marginal utility of leisure and thus discouraging higher labor supply. These two effects cancel out. A lower fertility rate reduces the effective tax rate on labor income, thereby encouraging more labor supply. The young agent's saving is given by:

$$a_{t+1} = \left[1 - \tau - g\eta - \left(1 + \frac{\varepsilon}{1+\beta\chi}\right)\frac{1 - \tau - g\eta + \phi/R^*}{1+\varepsilon}\right] w_t l_t + \frac{\beta\chi}{1+\beta\chi} v_t.$$

The savings of the young can be decomposed into two parts. The first part captures savings out of the present value of after-tax wage income and expected pension benefits, while the second part is the saved portion of received bequests. It is straightforward to show that given the size of wage income and bequests, higher life expectancy increases both components of savings as it effectively makes the young more patient. This effect is more pronounced with a more generous pension system. Lower fertility frees up more income to be saved, although this effect is partially mitigated by the fact that it also increases labor supply and hence induces more consumption and less saving. A more generous pension increases resources in old age, thus reducing the working age population's incentive to save. Of course, demographics and pension generosity may also affect wage income and bequests in equilibrium, which is examined below.

Public PAYG pension system

There is a PAYG public pension system with defined benefits. Total pension payout, B_t, is the product of benefits per retiree, b_t, and the number of retirees, N_t^o. The government issues one-period debt. Debt service in period t is $R^* D_t$. New borrowing is D_{t+1}. The government (flow) budget constraint is given by:

$$\tau w_t L_t + D_{t+1} - B_t - R^* D_t = 0.$$

The government's solvency constraint is:

$$\sum_{t=0}^{\infty} (R^*)^{-t} (\tau w_t L_t - B_t) \geq R^* D_0.$$

For simplicity, we assume $D_0 = 0$. Public savings represent the government's net asset position, given by:

$$S_t^G = -D_{t+1}.$$

To focus on how pension system characteristics affect saving, pension generosity and the tax rate are treated as exogenous parameters rather than the endogenous outcome of a government's optimization problem.

Equilibrium

We assume away technological progress and set $A_t = 1$. In equilibrium, the capital/labor ratio is constant and pinned down by the global interest rate. Therefore, the wage rate is also constant. Individual labor supply is thus also constant and a function of demographic and pension parameters. This leads total labor supply, the capital stock, and output to all grow at rate g.

It is also straightforward to show that the tax revenue, T_t, and pension expenditure are constant as share of GDP.

$$\frac{T_t}{Y_t} = \tau(1-\alpha)$$

$$\frac{B_t}{Y_t} = \frac{(1-\alpha)\chi\phi}{g}$$

We impose the restriction that $\tau \geq \chi\phi/g$ to ensure that the government's solvency constraint is satisfied (as it runs a permanent primary surplus) and that $g > R^*$ so that the asset-to-GDP ratio converges to a finite steady state. The public saving-to-GDP ratio is given by:

$$\frac{S^G}{Y} = (1-\alpha)\left(\tau - \frac{\chi\phi}{g}\right).$$

Aging (a higher old-age dependency ratio owing to higher life expectancy and/or a lower fertility rate) and higher pension system generosity decrease public saving, as more pension expenditure is required.

The steady-state size of bequest is given by:

$$v = \frac{(1-\chi)R^*a}{g},$$

which is increasing in the interest rate. In equilibrium, the saving rate of a young worker is characterized by a first-order difference equation, which in steady state is given by:

$$a = \frac{\left[(1-\tau-g\eta) - \frac{(1-\tau-g\eta)+\phi/R^*}{1+\varepsilon}\left(1+\frac{\varepsilon}{1+\beta\chi}\right)\right]}{1-\frac{(1-\chi)R^*}{g}\frac{\beta\chi}{1+\beta\chi}}wl.$$

Aggregate private saving is simply $S_t^P = aN_t^Y$, as the retirees consume all income and keep no savings. A higher old-age dependency ratio tends to lower aggregate saving due to the composition effect, as more of the population become retirees. The private saving ratio is given by:

$$\frac{S^P}{Y} = \frac{\left[(1-\tau-g\eta) - \frac{(1-\tau-g\eta)+\phi/R^*}{1+\varepsilon}\left(1+\frac{\varepsilon}{1+\beta\chi}\right)\right]}{1-\frac{(1-\chi)R^*}{g}\frac{\beta\chi}{1+\beta\chi}}(1-\alpha).$$

The private saving rate decreases with the generosity of the public pension system. A lower fertility rate increases the private saving rate, as demonstrated in the section on the young agents' problem. In addition, lower fertility increases the size of bequests relative to output. The impact of higher life expectancy on the private saving rate is ambiguous, as it decreases the size of bequests.

ANNEX 3. Private Saving: Regression Variables, In-Sample Performance, and Overview of Empirical Literature

Empirical specification for private saving. Building on the testable predictions of our model, we estimate the determinants of private saving, focusing on the impact of demographic factors and pension system design:

$$S^{P}_{i,t} = \alpha + \beta \times X_{i,t} + \gamma \times Y_{i,t} \times X_{i,t} + \delta \times S^{G}_{i,t} + \theta \times Z_{i,t} + \mu_i + \mu_t + \varepsilon_{i,t},$$

where subscripts i and t denote country and year, respectively. X is a vector of demographic variables; $S^{G}_{i,t}$ is the level of government saving as a share of GDP; Z is the vector of standard determinants of private saving from the empirical literature and the theoretical model described in Annex 2; and μ_i and μ_t control for the effects of unobserved country characteristics and common shocks across time, respectively. The main demographic variables included are the old-age dependency ratio and life expectancy at age 40. Pension system characteristics Y are represented by time-variant dummy variables indicating (1) whether public pensions are relatively generous or not and (2) the existence of a defined contribution (funded) pension scheme. The relative generosity of pension systems is captured by the product of the average pension as a share of GDP per worker (the benefit ratio) and the number of pensioners divided by the population over 65 years of age (the coverage ratio). We focus on a binary generosity variable, as our analysis suggests that generosity significantly influences private saving beyond a certain threshold. (Below this threshold, the empirical relationship is much weaker.) We choose to put the threshold at the 75 percent quartile, thus labeling the top 25 percent of countries as having generous pensions systems, for which our dummy variable takes the value of 1.

Sample. The sample contains more than 4,500 observations spanning the period from 1960 to 2015 and covering 70–80 countries. The panel data set is unbalanced, with the number of time observations varying across countries. Annex Table 3.1 contains a description of the variables used in the regression.

Control variables. The main control variables included in the baseline specification are informed by the theoretical framework, previous empirical research (for example, Loayza and others 2000 and Grigoli and others 2014), and data availability. The variables include the employment rate (measured as the share of employed in the total population), as precautionary saving can increase with unemployment risk (see Berloffa and Simmons 2003); and financial depth (measured by the ratio of private sector credit to GDP), as financial development can relax liquidity constraints, reducing the need for precautionary saving. The impact of the real interest rate on private saving depends on whether the income effect outweighs the substitution and wealth effects. Regressions also include other macroeconomic variables (real GDP growth, inflation, terms of trade) commonly found to be important determinants of private saving (see Annex Table 3.2).

Robustness. The robustness of the baseline results was tested against different samples and model specifications (results available upon request).

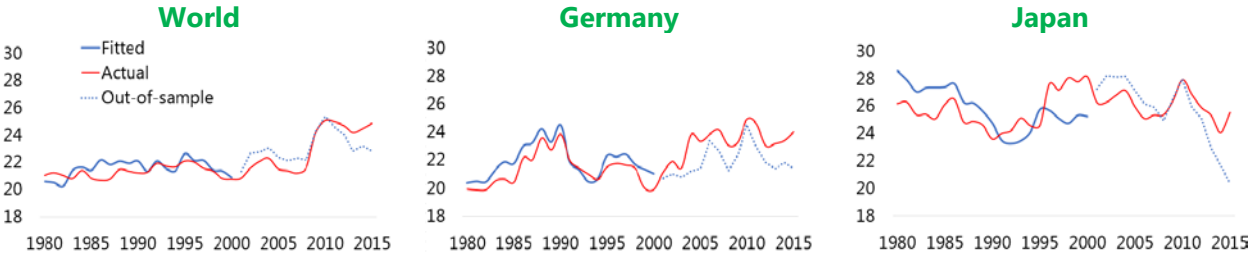
- While our preferred specification uses annual data with country and time fixed effects, we also test the robustness of the results averaging all variables over three and five years. The latter specification has the advantage of abstracting from the business cycle and reducing the impact of measurement error, at the cost of losing information about temporal dynamics of saving rates. We also run the estimation on separate samples for (1) advanced economies and (2) emerging market and low-income countries. As a further check, we project saving using specification (5) from Table 1 instead of our baseline specification (4). The basic thrust of the results remains unchanged.
- The estimated impact of pension system variables is robust to including different variables. The results broadly stand when controls are introduced for further covariates, including the share of public health expenditure (which affects the level of precautionary saving), expected life expectancy of a current 60-year-old (instead of a 40-year-old), share of prime savers (ages 45–64) as a proportion of the total working age population, overall quality of institutions, fertility and mortality rates, and young-age dependency ratio. The results are also robust to using the replacement rates instead of the generosity variable for a smaller subsample of Organisation for Economic Co-operation and Development countries. A specification including the government debt level as an additional control variable indicates that high government debt depresses private saving. Using future instead of current values for the old-age dependency ratio or using future (projected) generosity also leaves the baseline results largely unchanged.
- Equation (1) entails a few additional technical issues. Some of the explanatory variables can be jointly determined with the private saving rate, so we have to account for joint endogeneity of the explanatory variables. Furthermore, we need to control for unobserved country-specific effects correlated with the regressors. We therefore do an estimation using the system generalized method of moments as a robustness check (Arellano and Bond 1991; Arellano and Bover 1995). The effect of demographic variables and interaction with demographic variables is robust to this specification.
- The private saving regression can also involve inertia. To allow for persistency in private saving data, we have estimated a dynamic specification that includes the lagged dependent variable to distinguish short- and long-term effects of explanatory variables. In addition, we estimate the equation using a mean group estimator, which provides consistent estimates of long-term effects (Pesaran and Smith 1995). Both approaches broadly confirm the baseline results.

In-sample performance. To gauge the model's fit, we compare the in-sample and out-of-sample projections to actual private saving globally and to the individual country cases of Japan and Germany. Specifically, we look at the in-sample fitted values for private saving for the period 1980–2000. We also gauge the out-of-sample performance, estimating the model on the data up to the year 2000 and using this model to project developments for the years 2001–15. Both lines, as well as actual values, are shown in Annex Figure 3.1. The in-sample predictions for global private saving are close to observed levels. In particular, the empirical model captures two main trends in the actual data well: (1) the steady trend in private saving as a share of GDP since the 1980s, and (2) the sharp increase in global private saving as a share of GDP in the second half of the 2000s. For individual countries, the model's fit reflects idiosyncratic developments. This is due to large heterogeneity in the development of saving rates across countries. For example, the model's in-sample prediction for

private saving in Germany matches actual values, but the out-of-sample performance misses the trend increase in the German private saving rate in the 2000s. In Japan, the out-of-sample performance is reasonable but misses the uptick in saving toward the end of the sample period.

Annex Figure 3.1 Fitted versus Actual Private Saving

(Percent of GDP)



Source: IMF staff calculations.

Note: World private saving estimates are obtained by weighing private saving of individual countries by their GDP in nominal US dollars. Standard deviation of the difference between predicted and real values in the World panel is 0.76; in Germany panel, 1.12; and in the Japan panel, 1.84.

Annex Table 3.1. Private Saving Regression Variables

Variable	Definition	Source
Public saving	Public saving as a percent of GDP	IMF, WEO
Old-age dependency ratio	Ratio of population 65 years and older to population aged 15–64	United Nations
Life expectancy at age 40	Life expectancy at age 40 years is the average number of years that a person at that age can be expected to live, assuming that age-specific mortality levels remain constant.	United Nations
Pension generosity	A dummy indicating whether a country's pension expenditure is above the 75th percentile (as a percent of GDP per capita) in the overall sample or for the country-specific sample	IMF
Defined contribution pension scheme	A dummy indicating that the country has a defined contribution scheme. It includes mandatory individual account schemes, which are normally financed through social security contributions, accumulate in personified accounts, and are managed by the private sector and occasionally by the public sector (also known as provident funds).	US Social Security Administration (various years)
Employment rate	Ratio of employed population to total population or labor force participation rate	WDI
GDP per capita	PPP-based per capita GDP	IMF, WEO
GDP growth	Annual real GDP growth rate	IMF, WEO
Real interest rate	Real interest rate	WDI
Inflation	Annual percentage change in consumer price index	IMF, WEO
Credit to GDP	Banking-sector private credit as a percent of GDP	WDI
Terms of trade	Ratio of the deflator of exports of goods and services to the deflator of imports of goods and services.	WEO

Source: IMF Staff.

Annex Table 3.2. Private Saving Determinants: Review of Empirical Literature [1, 2]

	Grigoli and others	Masson and others	Edwards	Bailliu and Raisen	Loayza and others	De Serris and Pelgrin	Haque and others	Li and others	Dayal-Ghulati and Thimann	Hufner and Koske	Schrooten and Stephan	De Mello and others	Rezk and others	Ferrucci and Miralles	Roehn
Demographics															
Young-age Dependency					[-]*										
Old-age Dependency	[-]*				[-]*	[-]*		[-]*		[-]*		[-]*			[+]
Total (young and old) Dependency		[-]*	[-]*	[-]			[-]*		[-]*		[-]		[-]*	[-]*	
Employment Rate [3]								[-]							
Income and Wealth															
Real per Capita Income	[+]*	[+]*	[+]*	[+]	[+]*		[+]	[+]*	[+]*	[+]*			[+]		
Growth of Real Income	[+]*	[+]*	[+]*	[+]*	[+]*		[-]		[-]		[+]*	(+)	[-]	[+]*	
Private Wealth [4]		[-]					[+]*					[-]*			[+]
Government Sector															
Public Saving	[-]*		[-]*		[-]*	[-]*					[-]*	[-]*			
Budget Balance		[-]*		[-]*			[-]*		[-]*				[-]*	[-]*	[-]*
Interest Rate															
Real Interest Rate	[+]	[-]	[-]	[+]*	[-]*	[-]*	[+]*			[+]*			[+]*		[-]
Relative Prices															
Terms of Trade	[+]*	[+]			[+]*	[+]*	[+]*	[+]*	[+]*			[+]*		[+]*	
Macroeconomic Uncertainty															
Inflation	[+]*	[-]	[+]		[+]*	[-]	[-]		[+]*	[+]*				[+]*	[-]*
Financial Sector Depth															
Money			[+]*		[-]				[+]*	[-]*	[-]*	[-]*			[+]
Private Sector Credit			[+]*	[-]*									[-]	[-]*	
Flow of Private Sector Credit	[-]*				[-]*										
Pension System															
Generosity of Pension System [5]			[-]*	[-]*					[-]*						
Funded Pension Scheme [6]				[+]*					[+]*				[+]*		
Other variables found significant															
Urbanization	[-]*		[-]		[-]*										
Government Current Expenditure		[-]*					[-]*							[-]*	
Government Capital Expenditure		[-]*					[-]*								
Income Distribution			[+]*												
Life Expectancy at Birth								[+]*							
Current Account Balance		[+]*									[+]*				
Business Saving															
Health Care Expenditure															
Government Financial Liabilities										[+]*					

Sources: Grigoli and others 2014 (table 4, column 6); Masson, Bayoumi, and Samiei 1998 (table 2, column 2); Edwards 1996 (table 2, columns 1–3); Bailliu and Reisen, 1998 (table 4.2, columns 1 and 3); Loayza and others 2000 (table 4, column 6); De Serris and Pelgrin 2003 (table 2, column 3); Haque, Pesaran, and Sharma 1999 (table 1, column 3); Li and others 2006 (table 2, column 7); Dayal-Gulati and Thimann 1997 (table 4, columns 1 and 2); Hufner and Koske 2010 (table 3); Schrooten and Stephan 2005 (table 3, column 1); De Mello, Kongsrud, and Price 2004 (table 1, column 3); Rezk and others 2009 (table 4); Ferrucci and Miralles 2007 (table 3, column 1); and Roehn 2010 (table 3, column 1).

[1]For the majority of studies, the dependent variable is private saving. In the others, the dependent variable is aggregate saving (Li and others 2006) and household saving (Hufner and Koske 2010).
[2]Studies are based on panel data models but use different estimation techniques.
[3]Li and others (2006) use labor force participation.
[4]Masson and others (1995) use the sum of beginning of period capital stock, government debt, and net foreign assets; Haque and others (1999) use the cumulative sum of past nominal private saving in percent of GDP; De Mello and others (2004) use house and equity price indexes as proxies; Roehn (2010) uses house prices and stock prices, which have opposite but insignificant effects on private saving.
[5]Edwards (1996) uses the ratio of public expenditure on social security and welfare to total public expenditure as a proxy for generosity; Bailliu and Reisen (1998) use government spending on public pay-as-you-go pensions divided by population older than 65; and Dayal-Ghulati and Thimann (1997) use expenditure on social security in percent of GDP.
[6]Bailliu and Reisen (1998) use pension funds' and life insurance assets scaled by the population between 19-65; Dayal-Ghulati and Thimann (1997) use pension funds' savings; Rezk and others (2009) use pension funds' assets in percent of GDP.
Note: (*) denotes statistical significance at 1, 5, or 10 percent level; if multiple specifications are used, signs and significance reflect at least one of the specifications.

Annex Table 3.3. Countries with Saving Projections

80 Countries in the Sample			
Armenia	Estonia	Lithuania	Singapore
Australia	Finland	Luxembourg	Slovak Republic
Austria	France	Malaysia	Slovenia
Azerbaijan	Germany	Malta	South Africa
Belarus	Greece	Mexico	Spain
Belgium	Honduras	Moldova	Sudan*
Bolivia	Hong Kong SAR	Mongolia	Sweden
Brazil	Iceland	Netherlands	Switzerland
Cameroon	India	New Zealand	Tajikistan
Canada	Indonesia	Nicaragua	Tanzania
Chile	Iran	Norway	Thailand
China	Ireland	Oman	Turkey
Colombia	Israel	Pakistan	Ukraine
Cyprus	Italy	Peru	United Arab Emirates*
Czech Republic	Japan	Philippines	United Kingdom
Côte d'Ivoire	Kazakhstan*	Poland	United States
Denmark	Kenya	Portugal	Uruguay
Dominican Republic	Korea	Romania	Uzbekistan*
Ecuador	Kyrgyz Republic	Russia	Venezuela
Egypt	Latvia	Saudi Arabia*	Vietnam

** Country not included in the projections owing to data unavailability.*

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