Six Ways Population Change Will Affect the Global Economy

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New estimates of economic flows by age combined with population projections show that in the coming decades (1) global GDP growth could be slower by about 1 percentage point per year, declining more sharply than population growth; (2) GDP will shift toward sub-Saharan Africa more than population trends suggest; (3) living standards of working-age adults may be squeezed by high spending on children and seniors; (4) changing population age distribution will raise living standards in many lower-income nations; (5) changing economic life cycles will amplify the economic effects of population aging in many higher income economies; and (6) population aging will likely push public debt, private assets, and perhaps productivity higher. Population change will have profound implications for national, regional, and global economies.

Introduction

The world is experiencing unprecedented demographic change with important economic implications. Population size, growth, age structure, and geographic distribution influence economies because of systematic features of the human life cycle. Labor productivity is highest in the middle years of life, and, hence, an increase in the population at middle ages contributes directly to national production. "Dependent" populations at young and old ages consume much more than they produce through their labor, with implications for living standards and intergenerational transfers. The global economic impact of population reflects national variation in the life cycle interacting with national differences in demographic change and productivity. Detailed estimates of the life cycle across 186 countries, based on

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National Transfer Accounts (NTA), lead to six important observations about the likely effects of population on the global economy.

Population growth should lead to a continuation of global GDP growth, but the impact may be modest because growth in the working-age population is concentrated in countries with low labor productivity. The shape of the economic life cycle, with high consumption and low labor supply at older ages, will heighten the global economic costs of population aging. Current spending patterns suggest that the high costs will be absorbed by prime-age adults rather than children or the elderly. Many pressing environmental, health, and economic issues, some of which are considered here, are global in nature and inextricably linked to population. Understanding the connections is essential.

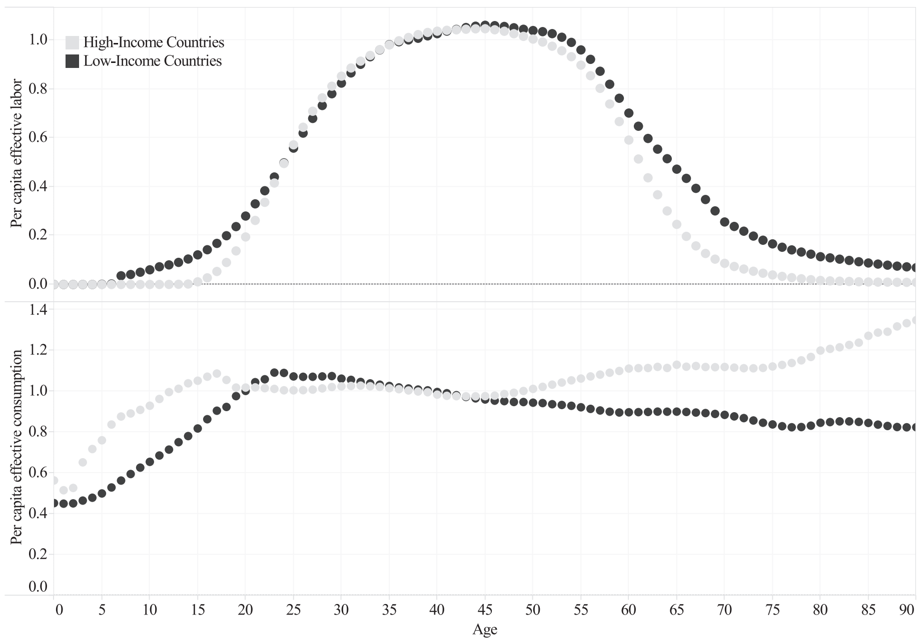
Life cycle fundamentals

The life cycle is key to understanding the economic impact of population and the methods employed in the analysis presented here. (See Supporting Information, SI, for more details.) Children and the elderly have material needs that are satisfied by consuming, but their production of goods and services through their labor is insufficient to meet those needs. Working-age adults produce enough to meet their own needs and, in addition, to support children and the elderly and to save for the future. Broad features of the life cycle are common to all economies, but important details vary. Per capita differences by age interact with population to influence aggregate trends in macroeconomic outcomes.

The data employed here are based on the NTA framework (Lee and Mason 2011; United Nations Department of Economic and Social Affairs: Population Division 2013), which provide estimates of how individuals at every age acquire and use economic resources to meet their current material needs, help others, and prepare for the future. NTA is complementary to the UN System of National Accounts (SNA) and measures economic flows in ways that are identical or similar to SNA concepts. NTA is distinctive because it provides estimates for each age, including consumption, saving, and public and private transfers, among others. NTA is constructed by drawing on aggregate economic accounts, administrative data, and household surveys. Country-specific research teams led by coauthors of this article have constructed NTA for their countries. The results presented here are the most recently available, and new techniques have been used to extend the analysis to 186 countries.

The per capita age profiles of consumption and labor income for individual countries play a central role in our analysis. The profiles are summarized in Figure 1 for economies falling into two different income groups (World Bank 2019). To facilitate comparisons across countries at very different levels of development, the values are standardized by dividing

FIGURE 1 Age profiles of consumption and labor income for high- and low-income countries



NOTES: Values are standardized by dividing by the average of values for the 30–49 age range. Averages are simple averages of the country values. Graph with four income groups available online in the SI. (www.ntaccounts.org)

age-specific values by the average of consumption and labor income respectively of those in the 30–49-year age range (chosen to come after education is completed and before retirement). The income group averages in this figure are simple averages, with each country weighted equally.

In NTA, labor income is an average across males and females (including zeros) of wages and salaries of employees including fringe benefits, and the value of labor of self-employed and unpaid family workers. Consumption includes both private household consumption and publicly provided goods and services such as education and health care. Details are given in Lee and Mason (2011), United Nations Department of Economic and Social Affairs: Population Division (2013), and the SI.

Per capita labor income, displayed in the upper panel, is low everywhere for children and the elderly, compared with working-age adults, but particularly in high-income countries. In low-income countries, standardized labor income is high for young children but it is low for those in their twenties and early thirties, reflecting high rates of youth unemployment and underemployment in many low-income countries.

The age profiles for per capita consumption in the lower panel show that children generally consume less than prime-age adults although the differences between children and adults are smaller in high-income countries. In many high-income countries, consumption by older children is higher than consumption by prime-age adults because of education spending. Per capita consumption tends to decline at older ages except in high-income countries where consumption tends to rise with age, primarily as a result of public spending on health care and long-term care. Life-cycle profiles for middle-income countries are provided in the SI.

When combined with population data, the standardized age profiles of labor income and consumption are used in a variety of ways to examine the impact of population on the economy. The standardized labor income profiles are used to construct a measure—effective labor—that is calculated by multiplying the age profile times a population age distribution and summing across age separately for each country. This captures age-specific variation in labor force participation, hours worked, unemployment, and wages (equation 1 in SI). Holding other things equal, effective labor age profiles are used to project the growth of total labor income and GDP that would arise solely from changes in population size and age structure. Projections of total effective labor are compared to similar projections of total effective consumers to determine how standards of living will be affected by changes in population. Effective consumers combine population with age profiles of consumption to incorporate the substantial variation in material needs by age. (See SI for equation 11.) Comparisons of consumption and its components, such as health and education, can be used to assess competition for resources across different generations or age groups. The gaps between consumption and labor income for children and the elderly quantify the burden that children, and the elderly may impose on public and private transfer systems. Relying on a longitudinal perspective, consumption and labor income profiles can be used to project the hypothetical wealth that would be needed to meet old-age needs.

Most studies of the impact of population change on development focus on a particular country or comparison of a few countries. Our approach here is able to exploit comparable detailed data for enough countries that we can consider global and broad regional implications of population change. Often in what follows, we will show the results of applying our baseline NTA age profiles to future population age distributions as projected by the United Nations Population Division (2019). These results should not be viewed as forecasts of what the future will bring, because our best guess is that the age profiles will change level and shape in the future. Instead, our calculations are intended to isolate and describe the effects of projected population change alone. Actual change over a short period will be the sum of changing age profiles times the initial population age distribution and the changing population age distributions times the initial age profiles. We are presenting only the second of these terms, and we simulate (extrapolate) it over very long time periods. This approach follows in a long tradition (Cutler et al. 1990). The future will look different than these simulations in part because of systematic change in the age profiles, such as relative increases in public transfers as economies develop (Mason and Miller 2018), but also because of the unsustainability revealed by calculations of this sort, pointing to the necessity for adjustments. We also present the results of applying the recent NTA age profiles to earlier populations going back to 1950, and similar caveats apply, but our focus is on the future.

Data

The age profiles of consumption and labor income were constructed using methods from NTA (Lee and Mason 2011; Mason et al. 2017; United Nations Department of Economic and Social Affairs: Population Division 2013). Age profiles were constructed for 186 economies, of which 60 (accounting for 85 percent of the global population) were estimated directly by national research teams who are members of the NTA Network (www.ntaccounts.org). Profiles for an additional 126 countries were estimated indirectly using methods described in the SI (Mason et al. 2017).

Age profiles are based on the most recently available data using nominal values in each country's own currency. Values are then converted in two ways. First, purchasing power parity (PPP) weights are used to calculate aggregate and per capita values in US dollars in 2010 prices. Second, age profiles are standardized by dividing age-specific values by the average of the age-specific value of consumption or labor income over the 30–49-year age range. Values are also calculated for income groups and regional groupings. In some instances, as indicated, profiles for groups are based on simple country averages. Otherwise indicated group values are weighted using the relevant variable—income or consumption.

Six key findings

In the analysis presented here, we emphasize the most direct channels by which population change impacts the economy and set aside more indirect channels that are less straightforward. We touch lightly on capital but not on human capital. We emphasize labor but not the changing role of women in the workplace. We discuss the impact of population aging on the economic security of seniors but do not explicitly model how policy reform might respond to demographic change and influence economic outcomes. Important research on these and other topics is typically carried out at the national level, but with implications for global outcomes. The research presented here provides a baseline for considering global change and identifying important ways population may contribute to and interfere with economic progress.

(1) *The era of population-driven economic growth is ending.*

The "demographic transition" initially led to global population growth that reached unprecedented levels in the early 1970s. Stated in the broadest possible terms, rapid population growth contributed to rapid growth in the number of workers and rapid growth in the number of workers contributed to rapid growth in GDP. As the demographic transition comes to an end, population is expected to grow more slowly and, after many decades, approach a peak that is substantially greater than is currently the case.

Unravelling the impact of global population growth on global economic growth is difficult for many reasons, but here we emphasize three aspects of demographic and economic heterogeneity. The first is population and age structure, the second is the connection between age structure and work, and the third is the link between work and economic output, or productivity.

The global trend in population is summarized in Table 1, column A. Between 1950 and 1975 population growth was very high at 1.92 percent per year. It dropped to 1.65 percent per year between 1975 and 2000 and to 1.2 percent per year for 2000–2020. Growth of 0.66 percent per year is projected for 2020 to 2060; slower, but fast enough to have a major impact on total population over a 40-year period. This growth was unevenly distributed around the world as will be discussed in more detail below.

The effect of population on labor depends on age structure and the connection between age structure and labor as summarized by the effective labor force. The effective labor force is similar to the working-age population, but it incorporates age-specific variation in labor force participation, hours worked, unemployment, and wages. Effective labor (L) estimates are based on country-specific per capita labor income profiles that are standardized by the labor income of those aged 30–49. Hence, effective labor does not incorporate country-specific differences in labor productivity.

The calculations in Table 1, columns B through F, were first done for each of the 186 individual countries so they reflect the geographic distribution and both the economic and demographic heterogeneity of the global population and their changes over time. These country Ls are then summed to find global effective labor. Incorporating this heterogeneity, we see that the growth of effective labor was slower than population growth between 1950 and 1975, peaked between 1975 and 2000 at a much more rapid rate of growth than population and has now entered a period of sharp decline. Between 2020 and 2060, effective labor is expected to grow at a rate similar to the rate of population growth.

The effect on GDP of growth of effective labor depends on where effective labor is growing because labor productivity varies considerably from country to country. This effect is incorporated using a weight $w_b(j)$ for each country j equal to GDP per effective worker in 2010 in country j. Combining age and place, $w_b(j)L(j,x,t)$, the impact on global GDP growth of demographic change is lower than population growth and effective labor. In every

TABLE 1 Growth rates for global aggregates (in percent)

	Annual growth rate (Gr)					
	Population	L	w_bL	GDP	Productivity	Gr(wL)/ Gr(GDP)
	(A)	(B)	(C)	(D)	(E)	(F)
1950–1975	1.92%	1.65%	1.27%	4.65%	3.34%	0.27
1975–2000	1.65%	2.21%	1.80%	3.20%	1.38%	0.56
2000–2020	1.20%	1.44%	1.14%	3.58%	2.42%	0.32
2020–2060	0.66%	0.62%	0.23%	2.65%	2.42%	0.09

NOTES: All global aggregates are based on values for 186 economies. Population data from the UN . L is effective labor, population weighted by standardized country-specific age profiles of per capita labor income. The equation $w_bL(t) = \sum_j w_b(j)L(j, t)$ is effective labor in economy j in year t weighted by productivity, $w_b(j)$, measured as GDP per effective worker, in economy j in 2010. GDP from 1960 to 1999 from Maddison (2001), from 2000 to 2018 from World Bank (2019), and 2019 to 2060 based on growth rate of w_bL plus assumed continuation of 2.46 percent productivity growth (SI). Column F is the ratio of C to D, the share of GDP growth accounted for by growth of weighted effective labor.

period, productivity-weighted effective labor (column C) is growing more slowly than effective labor because the productivity weights are highest in high-income countries where growth of effective labor is slow or negative. The difference ranges from 0.3 to 0.4 percent per year. As a general pattern, the effective labor force was growing more rapidly in low productivity countries than in high productivity countries. For the next 40 years, $w_b L$ is projected to add only 0.23 percent per year to GDP growth compared with 1.8 percent per year for 1975–2000. Only nine percent of future GDP growth is projected to be the direct result of demographic change compared with 56 percent during 1975–2000 (column F). The era of global GDP growth fueled by population numbers is coming to an end.

GDP growth rates and the size of the economy are important for at least two reasons. First, they are critical in determining carbon emissions. Demography is an important driver of both growth and size, and its influence at the global level is better measured by productivity-weighted effective labor than by population size or by effective-worker L. The estimated elasticity of carbon emissions with respect to population growth, which is imprecisely estimated as unity in both high-income and developing economies, should apply for productivity-weighted effective labor (Bongaarts and O'Neill 2018; Liddle 2015). The sharp drop in the growth rate of $w_b L$ should translate roughly into a one-for-one drop in growth of emissions. The second reason is that slower anticipated growth of GDP may discourage investors, reducing aggregate demand and potentially contributing to secular stagnation (Keynes 1937; Rachel and Summers 2019).

(2) *Population change will drive large regional shifts in economic activity: decline in the shares of global economic activity in East and Southeast Asia, Europe, and North America; and an increase in the shares of Central and South Asia and sub-Saharan Africa. Economic shifts should be greater than population shifts.*

Countries belonging to the same UN subregion are grouped based on the projected growth of effective labor for the subregions between 2020 and 2060. Group I consists of countries belonging to subregions projected to experience decline: East Asia and all of the subregions of Europe. The effective number of workers is projected to decline by 0.45 percent per year between 2020 and 2060, compared with growth of 1.15 percent per year between 1950 and 2020. Group I's share of global labor is projected to drop from almost half in 1950, to 31.9 percent in 2020 and to 18.1 percent in 2060.

Group II consists of subregions projected to experience slow growth between 2020 and 2060 in the effective number of workers, that is, less than 0.5 percent per year. All of the Americas, Southeastern Asia, and Oceania, with the exception of Melanesia, fall into Group II. Average growth is projected at 0.34 percent per year, which is a sharp decline from the growth of 2.09 percent between 1950 and 2020. The share of global effective labor is projected to be stable at around half between 2020 and 2060 compared with 40 percent in 1950 (Table 2).

Group III consists of countries in Western and Central Asia, Northern and Southern Africa, and Melanesia. Effective labor of these subregions is projected to grow moderately, at between 0.5 and 1.0 percent per year, over the next four decades. Of the four groups, they are the smallest, rising to close to 10 percent of global effective labor by 2060, compared to almost 8 percent in 2020 and 4.5 percent in 1950.

Group IV consists of countries belonging to Eastern, Middle, and Western Africa with projected effective labor force growth in excess of one percent per year. On average, the projected growth rate of 1.57 percent per year for 2020 to 2060 is much slower than between 1950 and 2020, but the drop has not been as great as in other regions. As a result, the group's global share of effective labor is projected to increase sharply in the coming decades. In 1950, about one in 20 effective workers lived in Group IV. In 2020, about one in 11 may live there and by 2060 about one in five may be working in these sub-Saharan African countries.

(3) *Prime-age adults are being squeezed by population aging.*

On average for the world as a whole per capita consumption is higher for prime-age adults than for children and seniors. In countries with older populations, however, per capita consumption for seniors is higher than per capita consumption for prime-age adults. Moreover, children living in aging countries also appear to gain, in terms of per capita consumption, relative to prime-age adults. Apparently, aging has not led to a generational divide, pitting the old against the young. Aging itself results largely from low fertility, which in turn reflects parental decisions to have fewer children and spend more on each, so perhaps this is not surprising. However, with population aging, consumption by prime-age adults is being squeezed by a shift in resources to both the young and the old. The connection between aging and generational distribution of consumption is charted for 186 economies in Figure 2.

Consumption for youth and elderly falls into four quadrants defined by median value lines. Older economies (dark gray) fall mostly in the northeast quadrant (relatively high consumption for both children and seniors), amplifying the economic effect of aging. The United States, not yet very old, falls between the northwest and northeast quadrants where consumption by children falls at the median global value, while consumption by seniors is astronomically high. In India and especially China, consumption by children is very high, possibly because child dependency has dropped to low levels while old-age dependency has not yet increased.

TABLE 2 Effective labor and population classified into four groups based on the projected growth rates of effective labor

	Effective workers (millions)			Share			Growth rate	
	1950	**2020**	**2060**	**1950**	**2020**	**2060**	**1950–2020**	**2020—2060**
I. Eastern Asia and Europe	577	1,291	939	49.3	31.9	18.1	1.15	−0.45
II. Americas, Southeastern Asia, Oceania except Melanesia	478	2,062	2,614	40.9	50.9	50.4	2.09	0.34
III. Melanesia, Western and Central Asia, Northern and Southern Africa	53	320	505	4.5	7.9	9.7	2.57	0.65
IV. Eastern, Middle, and Western Africa	62	377	1,128	5.3	9.3	21.7	2.57	1.57
Combined	1,169	4,051	5,185	100.0	100.0	100.0	1.77	0.35

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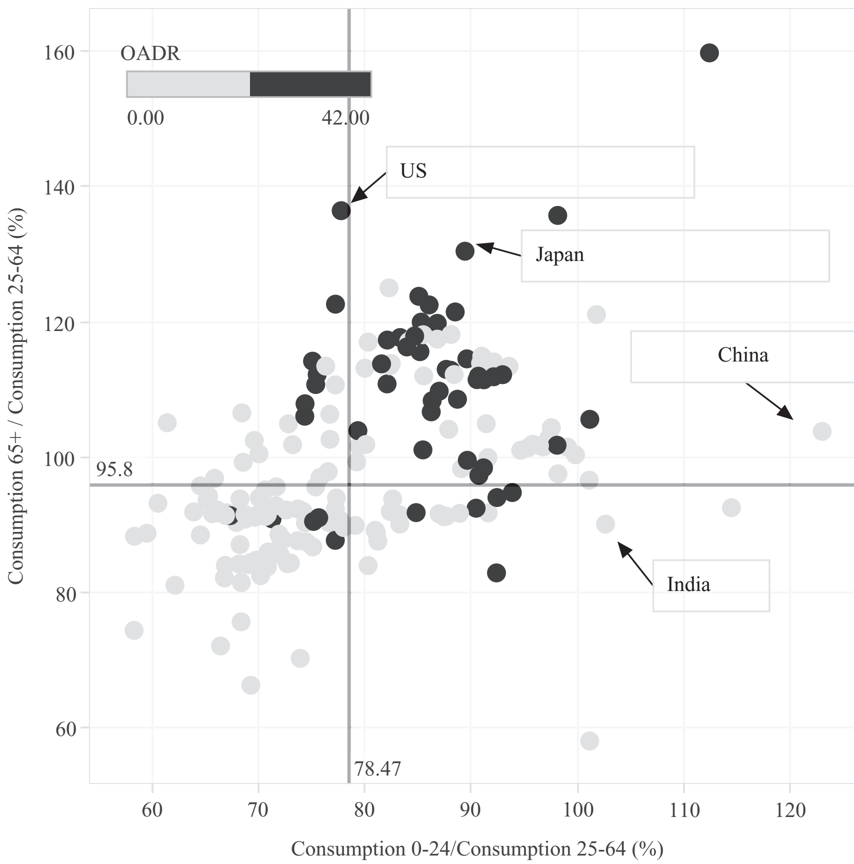
TABLE 2 (Continued)

	Population (millions)			Share			Growth rate	
	1950	2020	2060	1950	2020	2060	1950–2020	2020—2060
I. Eastern Asia and Europe	1,225	2,423	2,221	48.4	31.1	21.9	0.97	−0.12
II. Americas, Southeastern Asia, Oceania except Melanesia	1,009	3,661	4,492	39.8	47.0	44.3	1.84	0.29
III. Melanesia, Western and Central Asia, Northern and Southern Africa	136	678	1,026	5.4	8.7	10.1	2.30	0.59
IV. Eastern, Middle, and Western Africa	163	1,026	2,404	6.4	13.2	23.7	2.63	1.22
Combined	2,534	7,788	10,143	100.0	100.0	100.0	1.60	0.38

NOTE: Groupings based on growth rates of effective labor, 2020–2060. The four ranges are <0.0, 0.0–0.49, 0.5–0.99, and 1.0+.

FIGURE 2 Per capita consumption for children (0–24) and the elderly (65+) as a percentage of values for those in the 25–64 age group, 186 economies, circa 2010, old and young countries

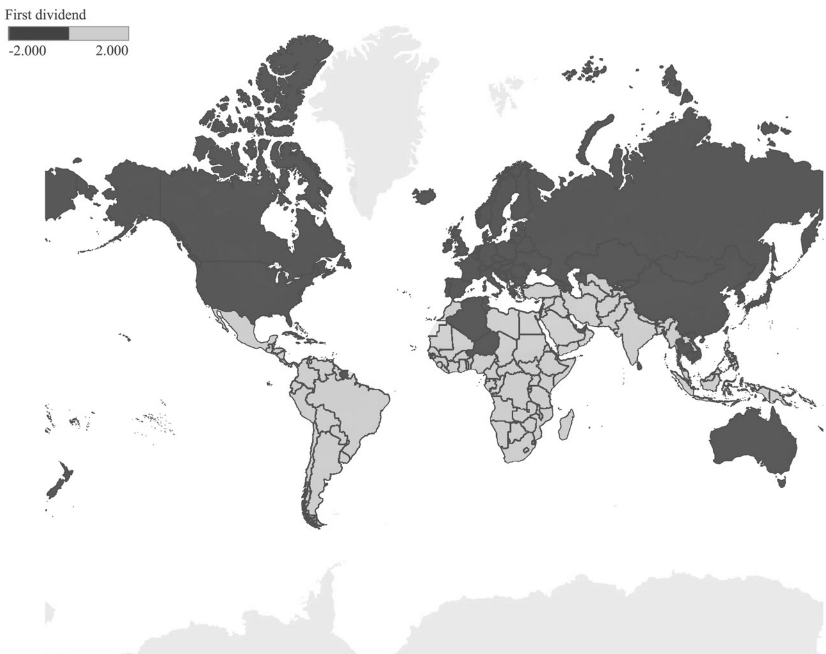


NOTE: Countries are classified by OADR, defined as the ratio of the population age 65+ to the population age 25–64.

(4) *Changes in age structure may boost per capita economic growth in low- and lower-middle-income countries but inhibit growth in high- and upper-middle-income countries.*

Standards of living are measured as consumption per effective consumer allowing for country-specific age differences in consumption, which are aggregated into income groups in Figure 1. Consumption per effective consumer (C/N) depends on three factors: saving (s), productivity or output per effective worker (Y/L), and the support ratio (L/N), effective workers per effective consumer. In Table 1, Y is measured by GDP. By definition $C/N = (1 - s)\ Y/L\ L/N$, and in growth terms, $\mathrm{Gr}[C/N] = \mathrm{Gr}[(1 - s)Y/L] + \mathrm{Gr}[L/N]$, where $\mathrm{Gr}[Z]$ refers to the instantaneous growth rate of the argument Z.

FIGURE 3 Countries of the world classified by whether their first demographic dividend is positive or negative, 2020

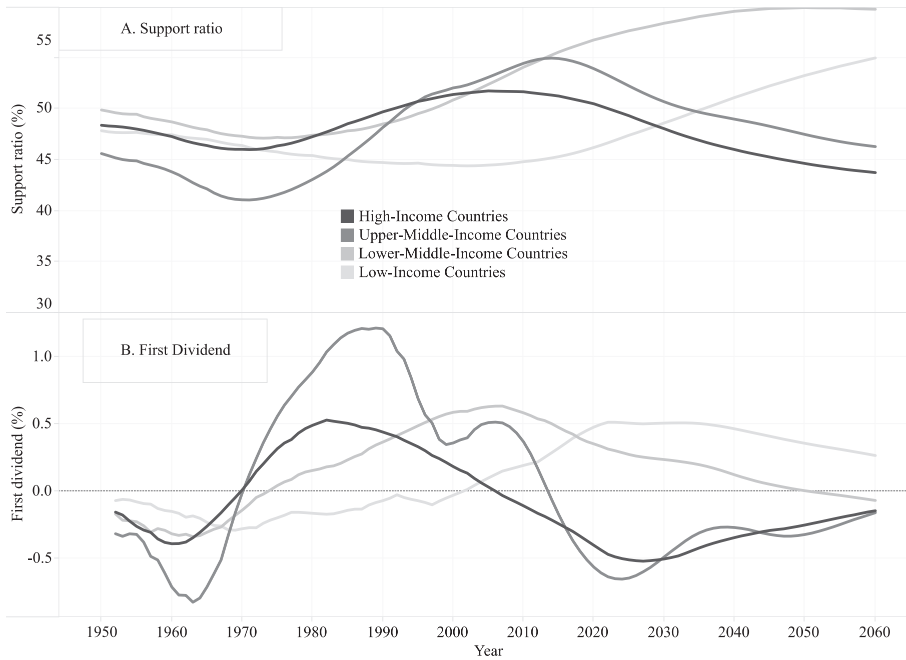


Here we are concerned with the direct effect of age structure on economic growth as captured by growth of the support ratio.

Growth of the effective labor force leads to higher standards of living if it exceeds growth in the effective number of consumers. Consumption per equivalent consumer, given age-standardized productivity and saving rates, varies in proportion to the ratio of effective workers to effective consumers as measured by the support ratio. Growth in the support ratio, when it occurs, boosts the rate of income growth per consumer and is called the "first demographic dividend" (Mason and Lee 2007). Eventually the support ratio begins to decline as a result of population aging, generating a negative first demographic dividend. A second demographic dividend, the term used for the effect of population on the growth of $(1-s)Y/L$, may more than offset the negative first dividend as is briefly discussed below.

The term demographic dividend is used widely and is defined in different ways by different researchers and organizations (Gribble and Bremner 2012; Lee and Mason 2006). Many studies, including this one, emphasize how changes in age structure influence economic growth (Bloom and Canning 2001; Bloom and Williamson 1998; Mason 2005; Mason and Lee 2007). Other studies emphasize the level of age structure rather than changes (United Nations Population Fund 2012).

FIGURE 4 Support ratio (A) and first demographic dividend (B) by income group, 1950–2060



NOTES: The demographic dividend is defined as the rate of growth of the support ratio. Peaks and troughs in the support ratio occur when the first dividend is zero. (See the SI.)

Currently, the great majority of the countries in the South are experiencing a positive first demographic dividend. In almost all of Latin America, Africa, and South Asia, the first dividend provides a tailwind to growth of consumption per effective consumer of up to one percent per annum. In Australia and New Zealand, every country in Europe, North America, and North Asia, the first dividend is negative. In Southeast Asia, Thailand and Vietnam both are experiencing significant negative first demographic dividends. In China, the support ratio is declining by 1.1 percent per year. A few North African countries have small negative first dividends (Figure 3).

The dichotomy in growth rates exhibited in Figure 3 led to a divergence in levels of the support ratio. In 1950, support ratios were similar in all income groups (Figure 4A). Remarkably, high-income economies and low-income economies had nearly identical support ratios with 48 effective workers per 100 effective consumers, while countries that now fall in the upper-middle-income group were somewhat disadvantaged. Through the 1950s and early 1960s, the support ratio was declining and the first dividend was negative, at all income levels (Figure 4B). Starting in the 1970s, a positive first dividend emerged except in low-income countries. By 2001, the positive first dividend led to a rise in support ratios in the middle- and high-income groups to between 51 and 52. The late emergence of a positive first dividend in low-income countries left them with particularly low support ratios in 2001 with seven to eight fewer effective workers per 100 effective consumers compared with the other income groups.

With the onset of the twenty-first century, the impact of population on standards of living flipped. In 2002, the first dividend turned positive in low-income countries after 50 years of decline. The first dividend has reached historically high levels as of 2020 and is projected to remain positive for many decades.

Favorable first-dividend effects have played out elsewhere. By 2060, the support ratio is projected to decline by eight to nine effective consumers per 100 effective workers in upper-middle- and high-income countries.

Over the next 30 years, demographic change may lead to some convergence in living standards around the world. In the next few years, the projected difference in population-driven per capita consumption growth between the low-income countries and the high-income and upper-middle-income countries will be about one percent per annum.

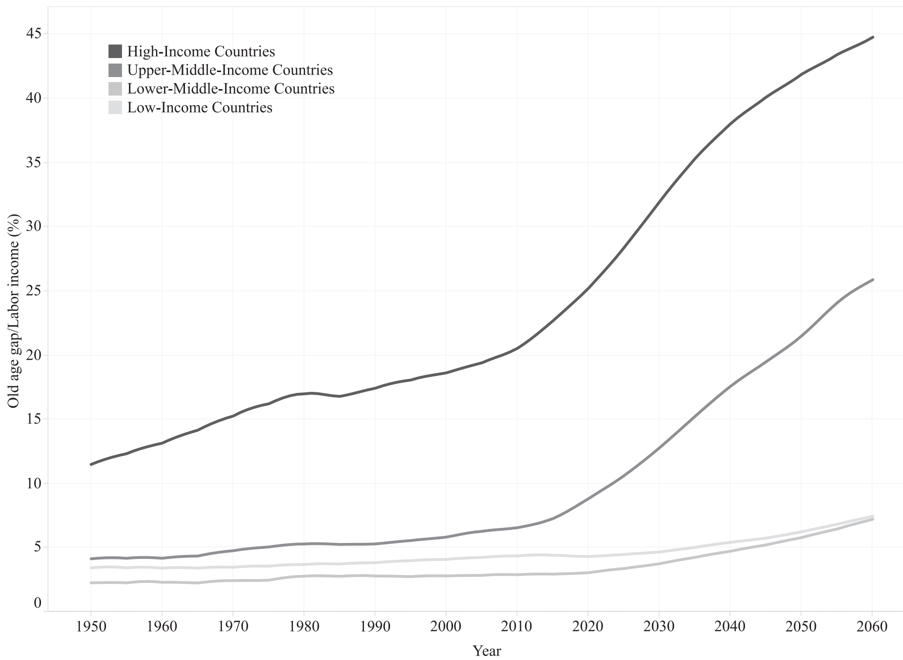
Second demographic-dividend effects are not discussed in detail here, but they could lead to higher growth in per capita income in countries at all levels of development. The prospects for this occurring seem particularly plausible in lower-income countries, which may benefit from increased investment in both human and physical capital particularly if capital inflows from higher income countries are substantial (Lee and Mason 2010; Lee, Mason et al. 2014).

(5) *Population aging, viewed from an economic perspective, is accelerating sharply in high-income and upper-middle-income countries.*

The economic impact of population aging depends on the costs and contributions of seniors that vary considerably from country to country. Data on the life cycles can incorporate important information about the consumption by children and seniors and the economic value of their labor (Mason et al. 2017; United Nations Department of Economic and Social Affairs: Population Division 2019).

Here we will use a new measure, the *old-age gap*, defined as consumption in excess of labor income for those 65 and older. Then the old-age gap ratio (OAGAP) expresses that gap as a ratio to aggregate labor income. An OAGAP of *x* percent indicates that a flat tax on labor income of *x* percent would be required to fund the needs of seniors that are not met by continuing to work, ignoring potential use of asset income. The OAGAP improves on the old-age dependency ratio (OADR) because the costs and contributions of older adults vary considerably across countries, over time, and in response to changes in public policy.

FIGURE 5 The OAGAP as a percentage of labor income, 1950–2060, four income groups



NOTES: The old-age gap (OAGAP) is the ratio of the difference between consumption and labor income for all persons 65 and older expressed as a percentage of total labor income for all persons.

High consumption and low labor income at older ages in high-income economies amplify the effects of population aging (see Figure 1). In middle-income and low-income countries, the OAGAP is only about half the OADR in 2019, but in high-income countries it is three quarters (not shown).

Until recently, aging has been concentrated in high-income economies, where the OAGAP increased by 13 percentage points since 1950 to reach 25.2 percent in 2020 (Figure 5). More recently, the OAGAP has accelerated sharply in high-income countries and is projected to reach 44.8 percent in 2060. Aging is also beginning to accelerate in upper-middle-income countries with the OAGAP projected to increase from 8.8 percent in 2020 to 25.9 percent in 2060. In lower-middle-income and low-income countries, economic aging will be modest for the foreseeable future.

For individual economies, the highest OAGAPs for 2060 are projected for Greece (108 percent), Japan (76 percent), and Puerto Rico (63 percent). The projected OADR for South Korea is highest for all countries in 2060 (98 percent) but its OAGAP is projected to reach only 55 percent because of a pattern of low consumption among the elderly in that country.

TABLE 3 Wealth gap as a percentage of total labor income

	Low-income	Lower-middle-income	Upper-middle-income	High-income
1980	142	88	192	510
2020	190	118	387	884
2060	264	227	736	1299

(6) *Population aging will increase pressure for more private assets and/or more public debt with an uncertain impact on capital.*

Many economists expect that population aging will raise the ratio of capital to labor (capital deepening), raising the productivity of labor, reducing interest rates, and increasing output (Eggertsson, Lancaster, and Summers 2019; Lee 2016). Capital deepening is expected because more per capita wealth will be required to fund longer retirements and the population share of wealth-holding elderly will rise. Retirement wealth can take two forms, however. One is real or financial assets such as accumulated pension funds, retirement accounts, and equity in a home, business, or farm. Another is "transfer wealth"—the expected value of net future support from the family or more typically from unfunded public pensions, health care, or long-term care that support seniors while relying heavily on taxes paid by prime-age adults. Unlike capital, transfer wealth does not raise productivity or output, and is an obligation on future generations.

A forward-looking measure, called the wealth gap, is used to assess the implications of aging for resource requirements into the future rather than just in any single year. The wealth gap is the wealth that would be required to fund old-age needs conditional on a country's existing consumption and labor income profiles. For 2020, the wealth gap varied from 118 percent of total labor income in lower-middle-income countries and 190 percent in low-income countries to a high of 884 percent of total labor income in high-income countries (Table 3). Wealth gaps are projected to grow much more rapidly than labor income over the coming decades. Between 2020 and 2060, the wealth gap is projected to increase relative to labor income by 39 percent in low-income countries, from 190 to 264; around 90 percent in middle-income countries, from 118 to 220; and by almost 50 percent in high-income countries, from 884 to 1299. On the assumption that the age profiles of consumption and labor income are maintained in the future, the rising wealth gap would lead to a society with large net transfers (public or private) from younger to older generations, large accumulations of public debt burdening future generations, or high rates of saving and capital accumulation. Economies that rely heavily on saving and capital accumulation to fund the wealth gap can expect population aging to raise national income, either from higher labor productivity or from increased asset income from abroad.

Because of the prospective nature of the wealth gap, it is not possible to determine how countries will fund it. But the approach to funding current old-age needs suggests great diversity in the strategies that countries might use. Many European and Latin American countries rely heavily on public transfers to fund old-age needs. In many Asian developing countries, such as Thailand, India, the Philippines, and Cambodia, assets play the dominant role. Many higher income Asian economies (China, South Korea, Taiwan, and Japan), the United States, and Great Britain take a more balanced approach to funding old-age needs, relying on both assets and transfers (Mason and Lee 2018). For economies that rely heavily on assets to fund the wealth gap, population aging could lead to capital deepening and higher rates of productivity growth. Further capital deepening could result if economies reform unfunded pension systems to contain growing public debt or move toward funded systems. Such policies would enhance prospects for second demographic dividends (Mason and Lee 2007). Economies that try to maintain unsustainable transfer programs or rely heavily on public debt may crowd out private investment, slowing productivity growth.

Important considerations

The goal of this paper is to anticipate how population change will influence the global economy, but major changes over the coming decades, such as climate change, new technologies, security, and pandemics, will have their own influences. Changes in these areas may reinforce or offset the economic effects of population highlighted here. It is also possible that changes in the future will not depart markedly from changes in the past.

Will growth of productivity, output per effective worker, differ substantially over the next 40 years compared with the last 20 years? Productivity growth in China has been rapid and very important and slower growth seems plausible to us, but perhaps rapid productivity growth in India or in sub-Saharan Africa will become the new driver of global economic growth.[1]

Future prospects may depend heavily on whether nationalism and shifts toward autarky take hold. The regional demographic changes emphasized here could be expected to lead to greater international migration than anticipated in the UN population projections, to an increase in international trade, and to an increase in international capital flows. These changes would benefit the global economy and regional development, but changes in public policy could curtail increased globalization.

Many global economic trends will depend on changes in behavior by families and changes in public policy that influence economic age profiles. We intend to explore these possibilities in the future as we estimate more

NTA time series. We anticipate that the changes we observe will depend heavily on initial conditions that vary widely around the world. In rich countries with old populations like Japan, we might see more moderate growth in health care spending at older ages, but many other countries might experience more rapid growth in health care spending. In countries with relatively old populations, labor income at older ages might increase significantly in coming years but in many countries that are becoming richer and more urbanized, people may choose to retire at a younger age. In countries with expansive public systems of generational support, in Europe and Latin America, for example, we would expect to see some retrenchment of these programs. In many other places, we might expect to see growth in transfer systems that provide support to seniors.

Six points have been selected to emphasize because they are all important, and we think the findings are robust. Perhaps the greatest uncertainty surrounds the impact of population aging on assets and debt because of the long time horizon involved in reaching conclusions. However, the available evidence points strongly toward an increase in the demand for wealth over time with considerable uncertainty about the form that that increased wealth will take—transfer wealth or assets.

Conclusion

During the last half of the twentieth century, countries around the world shared a common population experience. Rapid population growth, and growth of the effective labor force, provided a significant tailwind to GDP growth. After several decades of decline in the 1950s and 1960s, the support ratio rose, helping to achieve higher standards of living. Sub-Saharan Africa did not participate fully in this experience because fertility rates did not decline as early there and, hence, its demographic dividend was delayed.

The countries of the world are now following more divergent paths. Population growth and a positive first dividend will both be concentrated in low-income and lower-middle-income countries. Broadly viewed, the impacts are likely to be mixed for these countries. Growth in GDP and income per effective consumer will both be high, leading to higher standards of living as conventionally measured, but also to increased environmental strains associated with growth in population and GDP.

The situation is different in the upper-middle-income and high-income countries. Effective labor is growing much more slowly, and in some cases is declining. Aging is becoming pronounced, leading to a declining support ratio. In these countries, GDP and income per effective consumer are likely to grow more slowly as a result of demographic change. Because the high-income and upper-middle-income countries have such large economies, developments there can dominate global economic trends. Global population is projected to increase by 30 percent between 2020 and

2060, despite a slowdown in its rate of growth. During the same period, setting aside potentially important effects of population on productivity growth, we project that population will push up GDP by only 9.6 percent, exerting less pressure on the natural environment than population alone would have led us to expect.

Many other aspects of the economy touched upon here will be influenced by demographic change over the coming decades. Among the most important are the effects of aging. Will substantial growth in the number of seniors lead to great generational disparities in resources? The cross-sectional data suggest that spending by prime-age adults may suffer more than spending by children and the elderly. Important longitudinal change is all but certain, but the economic ramifications are unclear and will depend heavily on whether current generations accumulate capital to meet their old-age needs or believe they can shift the increasing aging burden onto future generations.

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Data and Materials Availability

All supplementary information, data and code used in the analysis will be made available online at www.ntaccounts.org.

Notes

1 Our global productivity growth assumption is in line with a recent careful assessment by Christensen, Gillingham, and Nordhaus (2018). We assume that productivity growth will continue at 2.32 percent per year for 2020–2060 (Table 1), measured as GDP growth per weighted effective worker. This can be compared to Christensen, Gillingham, and Nordhaus's median projection for 2010–2050 of 2.2 percent for productivity measured as GDP growth per capita in the population based on statistical

analysis of past trends. When we re-express our assumed rate in comparable per capita terms, it is 1.99 percent, in quite close agreement.

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