Population Dynamics and Economic Growth: From Demographic Dividend to Demographic Drag?*

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Abstract

This paper examines the extent to which changes in working-age shares associated with population aging might slow economic growth in upcoming years. We first analyze the economic effects of changing working-age shares in an empirical growth model using country panel data from 1950–2015. We then juxtapose the estimates with predicted shifts in population age structure to project economic growth in 2020–2050. A key novelty of our approach is the distinction between chronological and functional measures of population age structure. Our results indicate that changes in population age structure will slow economic growth throughout much of the world. However, widely applied chronological measures of population age structure tend to overstate this slowdown as they miss the fact that expansions of labor potential due to improvements in functional capacities among older people can cushion much of this demographic drag.

JEL classification: J11, O11, O47

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1 Introduction

Population growth and age structure change dramatically as countries transition from high to low rates of mortality and fertility. These changes present an opportunity for societies to substantially raise living standards. Initially, mortality declines faster than fertility, producing a bulge of young dependents that tends to depress economic growth. However, once fertility decline accelerates and this bulge of young people progresses into the working ages, economic growth can take off. The growing ratio of working-age people in the total population raises labor input; promotes productivity; and frees resources for saving, educational attainment, and innovation.

Bloom et al. (2003) label this growth take-off the *demographic dividend*. Countries harness it if they productively employ their labor potential and create opportunities for physical and human capital investment. The dividend dissipates once countries complete the demographic transition. However, as fertility remains below long-run replacement rates in many countries and large cohorts progress to older ages, population age structures fail to stabilize in the foreseeable future. This threatens to turn the demographic dividend into a *demographic drag*. How these powerful and unprecedented population dynamics will affect economic growth remains unclear.

In this paper, we investigate the likely consequences of contracting working-age shares—the proportion of the population that is of working age—for growth of income per capita in subsequent years. To this end, we examine the economic effects of population aging through the lens of a standard empirical growth model that incorporates population age structure. Within this framework, we test implicit assumptions underlying research on the demographic dividend and shed light on how informative this abstraction is for past and future implications of population aging.

A key novelty of our approach is the distinction among different conceptualizations of population age structure. Conventional measures of age structure define working ages based on chronological age. These measures are *retrospective* in that they count *years already lived*. By design, retrospective measures of age structure are ill-suited for comparisons across countries and over time because they ignore people's age-specific functional capacities and thus miss heterogeneity and changes in age patterns of mortality, disability, and work capacity (Fries et al. 2011; Cutler et al. 2006, 2014; Kotschy et al. 2025). Here we contrast retrospective with prospective measures of age structure that were developed by Sanderson and Scherbov (2005, 2007, 2010, 2019). *Prospective* measures of age structure define entry into old age with a variable age threshold that depends on *expected years of life ahead* and that correlates, as we will show, with functional capacity in terms of mortality, disability, body strength, and cognitive capacity at the macro level. By characterizing labor potential under fixed and evolving functional capacities, retrospective and prospective measures of age structure indicate bounds for how changes in working-age shares might affect future economic growth.

Based on this distinction, we answer two research questions. Will foreseeable changes in the

working-age share slow economic growth? And to what extent does this effect depend on the conceptualization of population age structure used to measure working ages?

The analysis proceeds in two steps. In the first step, we develop an empirical growth model that uses an accounting identity to describe the effects of population age structure on economic growth, which we then fit to panel data for 145 countries observed throughout 1950–2015. In the second step, we input demographic predictions into the fitted model to estimate the consequences of changes in population age structure for projected growth of income per capita in 2020–2050. Our projections contrast scenarios for retrospective and prospective measures of working-age shares with a counterfactual scenario in which population age structure is fixed. Quantitative differences among these scenarios indicate a range for the effect of changes in working-age shares on the pace of economic growth; moreover, they allow us to gauge the extent to which expansions in labor potential associated with improvements in functional capacities can counteract this effect.

Our empirical model leverages within-country variation in working-age shares in a dynamic panel, allowing for economic convergence and controlling for physical and human capital, quality of economic institutions, population health, and growth trends. We address challenges in the identification of the effects of working-age shares on economic growth in three ways. We i) use an instrumental variables approach; ii) verify that our estimates match parameter constraints implied by the model; and iii) confirm the results' stability with respect to alternative measurement of labor potential, sample composition, model specification, and the calibration of selected parameters.

The empirical model successfully reproduces patterns of economic growth observed in the data. Our estimates conform with stylized facts of economic literature and closely replicate income per capita levels in within-sample projections. Specifically, the results document that shifts in population age structure significantly affect economic growth. A 1 percent increase in the working-age share raises income per capita by about 1 percent through an immediate growth effect and by 0.1–0.4 percent in subsequent periods through a level effect. These patterns are stable across specifications and over time and hold for both Organisation for Economic Co-operation and Development (OECD) and non-OECD countries.

The projections for 2020–2050 show that future growth depends not only on how population age structures change as cohorts pass through the age distribution but also on how labor potential changes with improvements in functional capacities. Contractions in working-age shares will slow growth; however, expansions in labor potential thanks to higher life expectancy could offset this slowdown. Compared with a counterfactual scenario without population aging, the average annual growth rate of income per capita across OECD countries is projected to slow by 0.8 percentage points if we measure working ages retrospectively but only by 0.4 percentage points if we measure working ages prospectively. These values define bounds for the average demographic drag with and without the conceivable gains from expansions in labor potential due to improved functional

capacities. When we focus on the country level, we find pronounced differences in growth that depend on heterogeneity in the pace and scale of demographic change.

Caution in interpreting projected economic growth is necessary. How much economies will grow depends on factors that are not fully foreseeable today such as technological progress. Our projections approximate growth processes that are exogenous to the model by extrapolating trends in the data. If our extrapolations systematically overstate or understate actual growth, projected income per capita *levels* will be inaccurate. However, the purpose of this exercise is *not* to accurately predict these levels. Instead, we seek to quantify the contribution of changes in population age structure to economic growth by comparing alternative projections across which only population age structure is varied and everything else is held constant. As the exogenous growth trends enter each projection, they do not change the *differences* between projections. Hence, the projected effects of changes in working-age shares on growth we derive from these differences are insensitive to the exact specification of exogenous growth processes, which is a key feature of our methodology.

Previous work documents that a falling youth share in the population creates the opportunity for a demographic dividend (Bloom and Williamson 1998; Bloom and Canning 2000, 2008; Bloom et al. 2003; Mason 2007; Bloom et al. 2009; Ashraf et al. 2013; Karra et al. 2017). However, the implications of a rising old-age population are still debated. This debate ranges from pessimistic predictions about inflationary pressure and economic stagnation due to shrinking populations (Goodhart and Pradhan 2020; Jones 2022) to modest negative effects of population aging on living standards (for example, National Research Council 2012, in the context of the United States). Some contributions even argue that capital deepening and automation may, at least temporarily, promote growth (Cutler et al. 1990; Acemoglu and Restrepo 2017).

Our results offer new insights into the economic ramifications of population aging in later stages of the demographic transition. Recent literature investigates the economic effects of population aging in simulations or analyses that are restricted to few countries (often the United States) and that tend to cover comparably short time horizons for estimation and projection. This literature finds that population aging will slow output growth through age patterns in labor supply and saving (Cooley and Henriksen 2018; Gagnon et al. 2021) and age patterns in innovation (Aksoy et al. 2019), depress growth of employment and productivity per hour worked (Maestas et al. 2023), and limit consumption growth (Sheiner 2014).[1] Here we examine the economic effects of population aging globally, using a framework that generalizes previous models designed for analysis of the demographic dividend (e.g., Kelley and Schmidt 2005; Crespo Cuaresma et al. 2014) and accounts for the separate effects of human capital and population age structure (Lutz et al. 2019; Kotschy

[1] Other related literature finds that population aging might impede macroeconomic performance through workforce aging (Feyrer 2007, 2008; Aiyar et al. 2016; Kotschy and Sunde 2018), decreased firm entry (Karahan et al. 2024), increased employment concentration in large firms and a lower labor share (Hopenhayn et al. 2022), and pressure on fiscal and health budgets (Lee and Skinner 1999; Bongaarts 2004; Rouzet et al. 2019).

et al. 2020). We focus on growth of income per capita to elucidate the effects of population aging on economic welfare per person rather than on growth of income per worker, which is of interest for the study of labor productivity in growth theory (Fernández-Villaverde et al. 2023). In taking a global view over a century, we show that a demographic drag is the flipside of the demographic dividend and demonstrate that a demographic drag will be the norm as countries advance through the later stages of the demographic transition. Our results document that shifts in population age structure will slow economic growth in 70 countries of our sample—virtually all those with working-age shares that contract in the near future.

By distinguishing between different conceptualizations of population age structure, we also add a new perspective on the quantitative effects of age structure on economic growth. For example, Maestas et al. (2023) predict 0.6 percentage points lower income per capita growth in 2020–2030 using variation across U.S. states in an analysis that is like ours in spirit but focuses on the retrospective population share aged 60 and older. Our projections predict a similar slowdown of 0.54 percentage points in this period for retrospective working-age shares (upper bound) but only a 0.26 percentage point reduction for prospective working-age shares (lower bound). This difference indicates that applying conventional retrospective measures of age structure overstates the potential effects of population aging for economic growth when the assumption of a uniform age pattern of health implicit in those measures is violated. Notably, this finding also implies that retrospective measures tend to overstate the length and size of a potential demographic dividend for countries with young populations, as we show in additional analyses. Consideration of prospective measures of age structure (or function-based alternatives) in economic analyses can address this problem.

Finally, our evidence suggests that promoting healthy aging has sizable economic gains over and above increased human welfare. In developed countries, life expectancy and functional capacity improve predominantly in adulthood and especially after 65 (Eggleston and Fuchs 2012). These improvements shape how people learn, work, and save over the life course and thereby determine individuals' economic wellbeing (Ben-Porath 1967; Bloom et al. 2007; Cervellati and Sunde 2013; Sánchez-Romero et al. 2016; Hansen and Strulik 2017; Kotschy 2021; Scott 2021b,c; Dalgaard et al. 2022a) and potentially boost aggregate labor productivity (Weil 2007, 2014; Bloom et al. 2024). Changing age patterns of health might also help counteract aging-induced slowdowns of economic growth by expanding people's labor potential into older ages (d'Albis 2023; Scott 2021a, 2023). Our approach identifies the economic gains associated with such expansions: perhaps half the projected economic slowdown in OECD countries could be offset if labor potential expanded with longevity. Whether countries can and desire to harness these gains will depend on people's preferences for retirement and the extent to which labor markets and health and social policy facilitate retaining workers productively in the workforce.

2 Conceptualization of Population Age Structure

To gauge the plausible consequences of population aging for economic growth, we distinguish between retrospective and prospective conceptualizations of population age structure. The two concepts differ in how they define the correspondence between age and functional capacity.

Retrospective measures of population age structure determine entry into old age by counting people's years lived since birth and comparing them with a *fixed* threshold. While these measures are easy to compute, they assume populations' age-specific functional capacities are stable across countries and over time. Consider an old-age ratio that calculates the proportion of people aged 65 and older relative to the working-age population 20–64. Using this metric to compare age structure over time posits that the average 65-year-old in 2020 is as functional as a 65-year-old in 1970 or 2050 (conditional on other determinants of productivity such as human capital and technology). However, gains in life expectancy indicate that functional capacity is improving over time—a fact colloquially summarized by "70 is the new 60." In the United States, for example, life expectancy at age 65 rose from 15 to 19 years in 1970–2020 and is projected to reach 23 years by 2050 (United Nations 2022b). If we believe 65 is the right age to categorize an average U.S. citizen in 1970 as old, classifying 65-year-olds in 2050 as old will inflate the measured old-age population and deflate the measured working-age population.

Prospective measures of population age structure evolve with people's functional capacities to facilitate comparisons across countries and over time. These measures, which were pioneered by Ryder (1975) and generalized by Sanderson and Scherbov (2005, 2007, 2010, 2019), determine entry into old age with a *variable* prospective old-age threshold (POAT) that changes with people's remaining life expectancy and that can exceed or fall short of 65 years. Sanderson and Scherbov define this threshold as the age at which remaining life expectancy falls below 15 years to match life expectancy at age 65 in low-mortality countries around 1970 (Sanderson et al. 2017). Under this definition, the prospective old-age threshold in the United States was about 65 in 1970, 72 in 2020, and is predicted to reach 76 by 2050 (Lutz et al. 2018). Analogous to the retrospective metric, one can construct a prospective old-age ratio that calculates the proportion of people equal to or older than the prospective old-age threshold relative to the working-age population 20–POAT. By relying on an evolving age threshold, this ratio balances intergenerational and cross-country differences among old-age and working-age populations.

Validity of the prospective measures requires that changes in the old-age threshold derived from remaining life expectancy reflect improvements in age-specific functional capacity. Our analysis relies on this threshold rather than on other potential proxies for age-specific functional capacity, such as physiological aging (Dalgaard et al. 2022b), (upper-)body strength (Bohannon 2019), or cognitive capacity (Skirbekk et al. 2012), because the necessary data are readily available

Table 1: Prospective old-age threshold and functional capacity

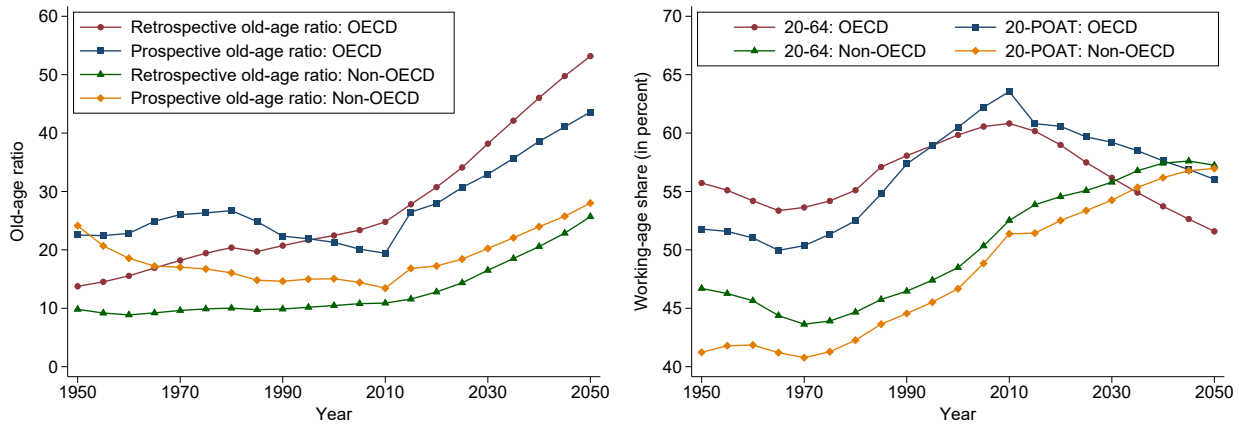
Dependent variable: prospective old-age threshold	Proxy for functional capacity			
	Life expectancy at age 65 (1)	Average deficits per person aged 50–79 (2)	Maximum grip strength (3)	Immediate word recall (4)
Regression coefficient	0.88***	−122.01***	0.13**	0.51**
	(0.04)	(28.94)	(0.06)	(0.23)
R^2	0.96	0.96	1.00	1.00
Within R^2	0.48	0.05	0.04	0.09
Countries	183	181	22	22
Observations	3842	1086	76	79

Note: This table shows correlations between the prospective old-age threshold (defined as the age at which remaining life expectancy falls below 15 years) and proxies for functional capacity in terms of mortality (1), physiological aging (2), body strength (3), and cognitive capacity (4). Data on the prospective old-age threshold are obtained from Lutz et al. (2018), data on life expectancy are from the World Population Prospects (United Nations 2022b), data on physiological aging stem from Dalgaard et al. (2022c), and data on physical prowess and cognitive capacity are aggregated from the English Longitudinal Study of Ageing (Banks et al. 2021), the Health and Retirement Survey (HRS 2022), and the Survey of Health, Ageing and Retirement in Europe (Börsch-Supan 2022). Measures of maximum grip strength and immediate word recall are age-corrected measures to account for country-specific quadratic age trends in the population age 50 and older. All regressions include country fixed and time effects. Standard errors are clustered at the country level and reported in parentheses. Asterisks indicate significance levels: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

for past and future periods across many countries. Nevertheless, we can test the extent to which the prospective old-age threshold correlates with functional capacity in these dimensions for the countries and periods for which data are available. To this end, we regress the prospective old-age threshold on life expectancy at age 65, average deficits per person aged 50–79, and maximum grip strength and immediate word recall in the population age 50 and older, while controlling for country fixed and time effects (Table 1). The prospective old-age threshold significantly correlates with all proxies of functional capacity. A one-year increase in life expectancy at 65 is associated with a 0.88-year rise in the threshold. Likewise, a one-standard deviation increase in maximum grip strength (2.12 kilograms) is associated with a 0.28-year rise in the threshold, and a one-standard deviation increase in immediate word recall (0.5 more words recalled out of a list of 10) is associated with a 0.26-year rise. Conversely, a one-standard deviation decrease in average deficits per person 50–79 (about 0.008 units of a frailty index) is associated with a 0.98-year rise in the threshold.

Retrospective and prospective measures of population age structure can produce qualitatively and quantitatively different demographic trends. Figure 1 contrasts retrospective and prospective old-age ratios and working-age shares for OECD and non-OECD countries between 1950 and 2050. Panel (a) displays an upward trend in old-age ratios since 2010, reflecting population aging in most countries around the world. Yet, the comparison between retrospective and prospective measures reveals two striking features. First, OECD countries appear younger when we employ prospective instead of retrospective measures, whereas non-OECD countries appear older. Hence, the retrospective measures conceal considerable variation in people's functional capacities. Second, the retrospective old-age ratio trends almost monotonically upward, whereas the prospective ratio reveals prolonged phases in which populations rejuvenate rather than age. Such patterns emerge when improvements in life expectancy outpace population aging.

Panel (b) depicts working-age shares for OECD and non-OECD countries, which differ appre-



(a) Old-age ratios

(b) Working-age shares

Figure 1: Differences between retrospective and prospective measures of population age structure

Note: This figure shows trends in old-age ratios and working-age shares for OECD and non-OECD countries. The figure compares trends for a retrospective definition of working ages (20–64) and a prospective one (20–POAT), where POAT denotes the age at which remaining life expectancy falls below 15 years. Retrospective old-age ratios refer to the quotient of people aged 65 and older relative to those aged 20–64. Prospective old-age ratios refer to the quotient of people at or above the POAT relative to those aged 20–POAT. Working-age shares refer to the proportion of people in the total population that are of working age. Data source: Lutz et al. (2018).

ciably depending on how working ages are defined. While prospective working-age shares exceed retrospective working-age shares in OECD countries after 1995, the reverse holds in non-OECD countries throughout. After 2010, population aging implies opposite trends in working-age shares between OECD and non-OECD countries. While retrospective and prospective working-age shares shrink and diverge in OECD countries, they grow and converge in non-OECD countries. By 2050, the two shares differ by 5 percentage points (about 10 percent of the potential workforce) in OECD countries, whereas they all but coincide in non-OECD countries.

For the foreseeable future, these patterns imply that retrospective measures of age structure will describe average labor potential less and less accurately in OECD countries and more and more accurately in non-OECD countries. Whereas retrospective and prospective working-age shares broadly coincided in OECD countries toward the end of the twentieth century, retrospective working-age shares likely understate average labor potential (and thus overstate a potential demographic drag) in OECD countries in upcoming years. In non-OECD countries, retrospective working-age shares likely provide a more accurate characterization of labor potential in upcoming years, unlike during the second half of the twentieth century when they overstated average labor potential (and thus overstated a potential demographic dividend).

3 The Effects of Population Age Structure on Economic Growth

3.1 Conceptual Framework

We examine the effects of population age structure on economic growth through the lens of an empirical growth model. This model expresses growth in income per capita across countries as a function of growth in production factors and changes in factor productivity (see, for example, Barro 1991; Mankiw et al. 1992; Caselli 2005; Jones 2005, 2016). With this abstraction we can assess the economic consequences of changes in population age structure, holding other determinants of economic growth constant. In doing so, we determine the extent to which countries' growth trajectories differ depending on how quickly and healthily their populations age.

Suppose time $t = 1, 2, \ldots, T$ evolves discretely and there are $i = 1, \ldots, I$ countries. Each country produces aggregate output Y_{it} (which equals aggregate income in a closed economy) using stocks of physical capital K_{it}, human capital H_{it}, and labor L_{it} as inputs:

$$Y_{it} = A_{it} K_{it}^{\alpha} H_{it}^{\beta} L_{it}^{1-\alpha-\beta}. \tag{1}$$

The parameters $\alpha, \beta \in (0, 1)$ denote the income elasticities with respect to physical and human capital. A_{it} denotes total factor productivity, which describes the economy's stock of technology and efficiency. All income elasticities sum to unity, such that production has constant returns to scale consistent with competitive factor and output markets. We assume all workers are identical and inelastically supply one unit of labor, so that the human capital stock H_{it} equals the number of workers L_{it} multiplied by average human capital per worker h_{it} (Lucas 1988).[2]

Expressing income in per worker units then yields

$$y_{it} = A_{it} k_{it}^{\alpha} h_{it}^{\beta}, \tag{2}$$

where $y_{it} = Y_{it}/L_{it}$ denotes income per worker and $k_{it} = K_{it}/L_{it}$ denotes capital per worker. We transform our model from per worker into per capita units because we are interested in economic welfare per person rather than labor productivity. This transformation requires us to further account for the economy's labor potential. Conceptually, labor potential can be understood as the proportion of the population that is of working age (the working-age share) or the proportion of the population that is working (the workforce share). We follow the first interpretation because the working-

[2]For simplicity and without loss of generality, we restrict h_{it} to the consideration of education and account separately for other dimensions of human capital, as we specify subsequently. Alternatively, these dimensions can be meaningfully incorporated in h_{it} by assuming human capital is an argument in a generalized Mincerian wage equation (see, for example, Hall and Jones 1999; Bils and Klenow 2000; Bloom et al. 2024). The exact specification of h_{it} is inconsequential for the projected effects of population aging on economic growth.

age share is a reliable proxy for potential labor force participation and, unlike realized labor force participation, insensitive to cyclical fluctuations of production (see, e.g., Bloom et al. 2000). Nevertheless, we confirm in additional analyses using workforce shares that this choice is inessential for our findings. Accordingly, we multiply y_{it} by the working-age share $w_{it} = L_{it}/N_{it}$ and derive production in terms of income per capita $\tilde{y}_{it} = Y_{it}/N_{it}$:

$$\tilde{y}_{it} = \frac{Y_{it}}{N_{it}} = \frac{Y_{it}}{L_{it}} \frac{L_{it}}{N_{it}} = y_{it} w_{it} = A_{it} k_{it}^{\alpha} h_{it}^{\beta} w_{it}. \tag{3}$$

This formalization implies that change in population age structure has first-order effects on income per capita growth so long as physical or human capital cannot perfectly substitute for labor input.

Taking logs and first-differencing expresses the model in growth rates:

$$\Delta \ln \tilde{y}_{it} = \Delta \ln A_{it} + \alpha \Delta \ln k_{it} + \beta \Delta \ln h_{it} + \Delta \ln w_{it}. \tag{4}$$

The extent to which the economy transforms production factors into output depends on total factor productivity: the technological level at which the economy operates and its efficiency in employing production factors. We model (total factor) productivity growth $\Delta \ln A_{it}$ as a conditional convergence process in which countries converge to their long-run productivity potentials (Bloom et al. 2004):

$$\Delta \ln A_{it} = \lambda \left[\ln A_{it}^{*} - \ln A_{it-1} \right] + \varepsilon_{it}, \tag{5}$$

where A_{it}^{*} denotes country i's period-specific productivity potential in its long-run equilibrium; $\lambda \in (0,1)$ denotes the rate at which a country adjusts toward this potential from productivity A_{it-1} in the preceding period; and ε_{it} denotes an error component that accounts for idiosyncratic productivity shocks—for example, through business cycles. According to this process, a country's productivity grows faster the further its productivity in the preceding period is from its current potential and the quicker it can adjust toward this potential. Importantly, this specification also ensures that countries' long-run productivity potentials can differ even after technological diffusion is complete.

For estimation and projection, we approximate country-specific productivity potentials and realized productivities in preceding periods with observable measures. Specifically, we assume the productivity potential is a function of the period-specific world technology frontier, which is captured by time effects τ_t; human capital per worker at the beginning of each period, which determines the country's capacity to innovate (Romer 1990; Strulik et al. 2013); and country-specific factors x_{it}, which may include demographic, economic, geographic, and institutional characteristics, as we specify subsequently. By including human capital per worker not only as a production factor but also as an engine of technological development, the model precludes potential bias that arises if one of these channels is omitted (Sunde and Vischer 2015). We proxy productivity in the preceding

period by income per worker times a factor ρ and, as before, transform it into per capita units. Under these assumptions, productivity growth reads:

$$\Delta \ln A_{it} = \lambda \left[\tau_t + \gamma \ln h_{it-1} + x'_{it} \delta - \rho \left(\tilde{y}_{it-1} - \ln w_{it-1} \right) \right] + \varepsilon_{it}. \tag{6}$$

This setup serves several purposes. First, it incorporates a lagged dependent variable, which we use to estimate the convergence rate. Second, it accounts for indirect effects of labor potential on economic growth, which, for example, might operate through the pool of people available for research, entrepreneurship, or contributions to public spending—effects that need not be captured by changes in labor potential alone. Third, adding ρ allows us to test whether other variables influence the speed at which countries converge to their long-run productivity potentials.

Inserting equation (6) in (4) and assuming $\rho = 1$ gives our baseline model:

$$\Delta \ln \widetilde{y}_{it} = \alpha \Delta \ln k_{it} + \beta \Delta \ln h_{it} + \Delta \ln w_{it} + \lambda \left[\tau_t + \gamma \ln h_{it-1} + x'_{it} \delta - \ln \widetilde{y}_{it-1} + \ln w_{it-1} \right] + \varepsilon_{it}. \tag{7}$$

According to this model, the growth rate of income per capita $\Delta \ln \tilde{y}_{it}$ over the interval $(t-1,t)$ increases with growth in physical capital per worker $\Delta \ln k_{it}$, human capital per worker $\Delta \ln h_{it}$, and the working-age share $\Delta \ln w_{it}$. It further rises with productivity growth at the world technology frontier τ_t; human capital per worker available for the invention of new technologies $\ln h_{it-1}$; labor potential in terms of the working-age share in the preceding period $\ln w_{it-1}$; and country-specific characteristics x_{it}, which include the quality of economic institutions and population health in the main analysis (and further covariates in robustness checks). In contrast, the growth rate decreases with past levels of income per capita $\ln \tilde{y}_{it-1}$, which reflects the notion that richer countries have less scope for economic convergence than poorer countries as they are closer to their productivity potentials. Finally, the growth rate varies with idiosyncratic productivity shocks contained in ε_{it}, which serves as the error term. The log structure allows us to interpret the parameters for all production factors including the working-age share as elasticities.

The baseline model implicitly assumes that countries follow uniform growth trends and converge to productivity potentials at the same rate. This assumption implies analytical parsimony and facilitates the interpretation of our projection results. Nonetheless, we also account for country-specific growth trends and convergence in an extended model:

$$\begin{aligned} \Delta \ln \tilde{y}_{it} \;=\; & \alpha \Delta \ln k_{it} + \beta \Delta \ln h_{it} + \Delta \ln w_{it} + \\ & \lambda \left[\tau_t + \gamma \ln h_{it-1} + x'_{it} \delta - \left(1 + \frac{\theta}{\lambda} \ln h_{it-1} \right) \left(\ln \tilde{y}_{it-1} - \ln w_{it-1} \right) \right] + \varepsilon_{it}. \end{aligned} \tag{8}$$

This extended model additionally includes country fixed effects and an interaction between human

capital per worker and productivity in the preceding period by assuming $\rho = (1 + \frac{\theta}{\lambda} \ln h_{it-1})$. Therefore, human capital may not only promote production and innovation but also expedite the adoption and implementation of existing technologies (Nelson and Phelps 1966; Benhabib and Spiegel 1994, 2005; Cervellati et al. 2023). Accordingly, countries converge faster to their productivity potentials the more human capital per worker they have. This extension accounts for additional heterogeneity, improving model fit in within-sample projections and increasing realism.

Importantly, our models constrain the effects of population age structure on economic growth. These effects depend on growth of the working-age share (growth effect) and its level in the preceding period (level effect). Under the null hypothesis, our model constrains the growth effect to unity and the level effect to λ. We use these constraints for specification tests when estimating the parameters of our models. Significant differences from these values would indicate misspecification of our model or endogeneity of the working-age share.

Changes in population age structure can also affect economic growth through its interaction with human capital per worker in the convergence term of the extended model. Our model constrains this convergence effect to θ. We do not report this effect explicitly as it tends to be minimal.

3.2 Estimation

Our analysis aims to examine the extent to which changes in labor potential might slow future economic growth. For this analysis, we must parameterize our model. Two options are possible for this parameterization: calibration based on estimates from the empirical growth literature and estimation using data. In our main analysis, we apply the estimation approach and show in extended analyses that our predictions are insensitive to this choice. A key advantage of the estimation approach is that it acts as a specification test, probing whether our model can reasonably reproduce the patterns of economic growth observed in the data.

We fit our empirical model with panel data for 145 countries observed in five-year intervals throughout 1950–2015. Our strategy for identifying the effects of changes in population age structure on economic growth has three aspects.

First, we use an instrumental variables approach that draws on lagged rather than contemporaneous variation in population age structure. This approach deals with reverse causality and potential confounding factors, which, for example, might operate through migration. We instrument changes in the working-age share over the interval $(t-1,t)$ with the predicted inflow of young workers into working ages based on the population share aged 15–19 in the preceding period $t-1$ (see Figure 2). This instrumentation leverages the fact that populations with unequal cohort structures experience more pronounced adjustments in working-age shares than populations with equal cohort structures; these adjustments, in turn, may affect economic growth through changes in labor potential (Kotschy

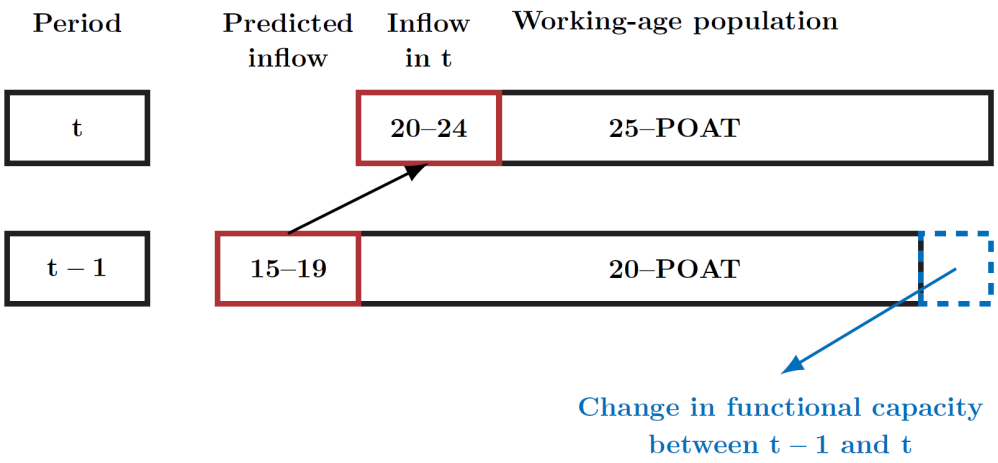


Figure 2: Instrumentation of changes in the working-age share

Note: This figure illustrates the first stage of our instrumental variables strategy. Changes in the working-age share over the interval $(t-1,t)$ are instrumented with the population share aged 15–19 in period $t-1$ as the predicted inflow into working ages (20–POAT). Working ages evolve with changes in the prospective-old threshold between periods $t-1$ and t, as indicated by the dashed rectangle (which may be positive, negative, or zero).

and Sunde 2018 and Maestas et al. 2023 previously used variants of this instrumentation).

This approach produces valid estimates so long as future workers do not anticipate productivity shocks beyond the trends in economic performance captured in our model. While we cannot test this assumption directly, we provide indirect evidence for its plausibility in specifications that resort to 10-, 15-, and 20-year cohort lags for instrumentation. As these lags grow larger, the instrument relies on variation closer to a cohort's birth period, such that forward-looking behavior becomes less and less likely to drive economic growth and population age structure in the observation period. In additional robustness checks, we also apply a related but slightly different instrumentation strategy using changes in total fertility rates to predict changing working-age shares 20 years later.

When fitting the model with country-specific growth trends and convergence, we account for bias that arises in dynamic panel models with fixed effects and few periods by using a system general method of moments estimator (Arellano and Bover 1995; Blundell and Bond 1998). Because these estimators tend to suffer from many weak instruments (Roodman 2009), we resort to the minimum necessary for estimation: the second lag of income per capita in the first-differenced equation and the lagged difference of income per capita in the levels equation, where we create one instrument for each variable rather than for each time period. In addition, we instrument growth of the working-age share with the first lag of the population share aged 15–19 in the first-differenced equation and with the first difference of that share in the levels equation, limiting the total instrument count to four.

Second, we test whether the parameter estimates for the working-age share match constraints on the economic effects of changes in population age structure that our model implies. The economic effects of changes in age structure depend on growth of the working-age share (growth effect) and

its level in the preceding period (level effect). Under the null hypothesis, our model constrains the growth effect to unity and the level effect to the rate of economic convergence. The tests support our empirical specification if they fail to reject the null hypothesis.[3]

Third, we verify the results' robustness with respect to alternative measurement of labor potential, sample composition, specification of instrumental and control variables, specification of parsimonious models, and calibration of select parameters. These analyses test whether the effects of population age structure on economic growth are similar when accounting for labor supply in terms of workforce shares and obtain for different country samples, observation periods, instrumental variables, and model specifications. Moreover, they account for potential economic effects of disability, population size, young-age and old-age ratios, trade openness, democracy, geography, ethnic fractionalization, and their indirect effects, which might operate through productivity growth or public debt. Together, these analyses examine the stability of the economic effects of population age structure, which is a necessary precondition for out-of-sample projections of economic growth.

3.3 Data Sources and Coding

Data on income, measured by gross domestic product, and physical capital are from Penn World Tables (Feenstra et al. 2015). Information on population age structure and educational attainment is from the Wittgenstein Centre for Demography and Human Capital (Lutz et al. 2018). Appendix A.1 lists the countries in our sample and reports descriptive statistics.

We combine population counts to construct retrospective working-age shares, which we define as the proportion of people aged 20–64 in the total population, and prospective working-age shares, which we define as the proportion of people aged 20–POAT in the total population. We also construct the corresponding workforce shares as alternative measures of labor potential, using data on labor force participation rates from the International Labour Organization (2021).

Data on educational attainment are coded according to the International Standard Classification of Education. We collate this information and construct population shares composed of individuals who have obtained post-primary—that is, secondary or more—education to measure human capital.

In the main analysis, we control for population health measured by life expectancy at birth (data drawn from United Nations 2022b) and quality of economic institutions measured by the Fraser Institute's index of economic freedom (Gwartney et al. 2017; Murphy and Lawson 2018). This index captures five aspects of institutions: i) size of government; ii) quality of the legal system and property rights; iii) stability of money and access to foreign currencies; iv) barriers to international trade; and v) regulation of credit markets, labor, and businesses.

[3]Changes in age structure can also affect economic growth through its interaction with human capital per worker in the convergence term of the extended model. We do not report this effect explicitly as it tends to be minimal. Results are available upon request.

Table 2: Population age structure affects economic growth

Dependent variable: income per capita growth	Prospective working ages (20–POAT)		Retrospective working ages (20–64)	
	Uniform growth trends and convergence (2SLS) (1)	Country-specific growth trends and convergence (GMM) (2)	Uniform growth trends and convergence (2SLS) (3)	Country-specific growth trends and convergence (GMM) (4)
Growth of working-age share	0.79***	0.98***	0.89***	0.92***
	(0.23)	(0.25)	(0.23)	(0.24)
Log working-age share ($t-1$)	0.13*	0.44	0.14**	0.24
	(0.07)	(0.34)	(0.06)	(0.18)
First stage				
Log population share 15–19 ($t-1$)	0.14***	—	0.15***	—
	(0.01)	—	(0.01)	—
Reduced form				
Log population share 15–19 ($t-1$)	0.11***	—	0.13***	—
	(0.03)	—	(0.03)	—
First-stage F-statistic	230.2	—	475.3	—
p-value growth effect	0.36	0.92	0.62	0.75
p-value level effect	0.28	0.36	0.19	0.38
AR(1) p-value	—	0.00	—	0.00
AR(2) p-value	—	0.63	—	0.34
Underidentification test p-value	—	0.00	—	0.00
Hansen test p-value	—	0.38	—	0.27
Diff-in-Hansen test p-value	—	0.20	—	0.11
Excluded instruments	1	4	1	4
Countries	145	145	145	145
Observations	1340	1289	1340	1289

Note: This table shows that population age structure affects economic growth. Estimates are obtained from two-stage least squares (2SLS) and system general method of moments (GMM) for a panel of 145 countries in five-year intervals throughout 1950–2015. All specifications instrument growth of the working-age share with the lagged population share of the age group 15–19. In specifications (1) and (2), the working-age population comprises people in the age range 20–POAT, where POAT denotes the country-specific old-age threshold at which remaining life expectancy falls below 15 years. In specifications (3) and (4), the working-age population comprises people in the age range 20–64. All specifications include covariates and control for time effects. Specifications (2) and (4) additionally account for country fixed effects by transforming the data with forward orthogonal deviations. The system GMM estimators instrument lagged income per capita using the second lag in the differences equation and the lagged first difference in the levels equation; the specifications use one instrument for each variable rather than for each time period (collapsed instrument set). Tests for serial correlation, underidentification, and overidentification check validity of the identifying assumptions. Standard errors are clustered at the country level and reported in parentheses. Standard errors in GMM specifications are computed with the two-step procedure and corrected for sample size (Windmeijer 2005). Asterisks indicate significance levels: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

In additional analyses, we include controls for disability from the Global Burden of Disease study (Vos et al. 2020), health deficits per working-age person compiled by Dalgaard et al. (2022c) from the same source, population size and young-age and old-age ratios (Lutz et al. 2018), the ratio of imports plus exports to output (Feenstra et al. 2015), the composite polity score (Marshall and Gurr 2020), the percentage of land area located in the tropics and within 100 kilometers of a coast or navigable river (Mayer and Zignago 2011), and ethnic fractionalization (Alesina et al. 2003).

4 Population Dynamics and Economic Growth

4.1 Does Population Age Structure Affect Economic Growth?

We begin the analysis by examining the extent to which population age structure influences economic growth and testing whether our conceptual model can reasonably explain the growth patterns observed in the data. Table 2 shows results for the model with uniform growth trends and convergence and the model with country-specific growth trends and convergence.

Population age structure affects economic growth. A 1 percent increase in the working-age share raises income per capita by 0.8–1.0 percent. In addition, a higher working-age share in the preceding period expedites growth by 0.1–0.4 percent. Together, these growth and level effects imply that increasing working-age shares provide the opportunity for a demographic dividend, whereas decreasing working-age shares pose the risk of a demographic drag.

Specification tests maintain the null hypothesis that the estimated growth and level effects align with the parameter constraints of the conceptual framework and do not differ systematically between retrospective and prospective measures of age structure. However, the exact extent to which shifts in population age structure influence economic growth may nevertheless differ between the retrospective and prospective definitions of working-age shares as the two measures systematically differ from one another (as discussed in Section 2).

The fitted parameters for the covariates conform with the predictions of our conceptual framework and match stylized facts in the literature on economic growth (Appendix A.2). Lagged income per capita correlates negatively with subsequent growth, consistent with economic convergence. Income per capita in turn correlates positively with faster accumulation of physical and human capital per worker and higher levels of population health and quality of economic institutions.

Diagnostic tests support our specifications. The first stage and reduced form show significant positive correlations between the predicted inflow into working ages and both growth of the working-age share and income per capita. First-stage F-statistics greater than 200 confirm instrument relevance. Likewise, Windmeijer's (2018) rank test rejects underidentification in the general method of moments specifications. The AR(1) and AR(2) serial correlation tests corroborate the validity of lagged variables for instrumentation. They rule out that residuals follow a near-unit root process and buttress the null hypothesis that residuals exhibit no higher-order serial correlation. Finally, the Hansen and difference-in-Hansen tests maintain the null hypothesis that the excluded instruments are orthogonal to the residuals.

4.2 Additional Results and Robustness Analysis

This section presents additional results that demonstrate the robustness of our findings with respect to (i) parsimonious model specifications, (ii) additional covariates and calibration of select model parameters, (iii) alternative specifications of the instrumental variables, (iv) sample composition and longer panel intervals, and (v) the use of workforce data.

Parsimonious model. Our conceptual model informs the empirical specifications, which express income per capita growth as a function of production factors and factor productivity. The idea behind this approach is to fit a model that reasonably matches economic growth in the data and

thus predicts economic growth in out-of-sample projections. An alternative approach would be to estimate a parsimonious model with minimal structure to focus on the overall effect of population aging (see Appendix A.3). The corresponding results point to indirect effects of shifts in population age structure on economic growth that operate through the covariates captured in our baseline model and show that our main findings do not hinge on the inclusion of specific covariates.

Additional controls and calibration of key model parameters. Extended analyses confirm the robustness of our findings with respect to additional covariates and the calibration of model parameters (Appendix A.4). These analyses document similar effects of population age structure on economic growth when we control for physiological aging and disability, population size, young-age and old-age ratios, trade openness, quality of democratic institutions, geography, and ethnic fractionalization. Moreover, they document that the estimated coefficients for the covariates are insensitive to the calibration of the economic effects of population age structure in line with the parameter restrictions of our conceptual framework.

Robustness of instrumental variables approach. Additional analyses show that our results are robust to alternative specifications of our instrumental variables and an instrumentation strategy based on lagged changes in total fertility rates in long panel intervals (Appendix A.5). These analyses document similar effects of population age structure on economic growth when changes in working-age shares are instrumented with (i) 10-, 15-, and 20-year cohort lags; (ii) both the predicted inflow into and outflow from working ages; and (iii) 20-year-lagged changes in total fertility rates.

Parameter stability across samples and panel intervals. The estimated effects of population age structure on economic growth are stable across samples and robust to the use of longer panel intervals (Appendix A.6). Our model assumes that population age structure affects economic growth to the same extent across countries and over time. This assumption echoes the notion that every country could collect a demographic dividend when it transitions from high to low rates of mortality and fertility. Without such regularity, developing countries could learn little from historical episodes in developed countries and projections of future growth would be futile. To support the stability assumption, we reproduce our main results for (i) OECD and non-OECD countries separately, (ii) abridged samples covering the periods 1950–2000 and 1965–2015, and (iii) 10-year panel intervals. The results align with our main estimates and support the stability assumption.

Workforce shares as an alternative measure for labor potential. The main analysis operationalizes labor potential in terms of the working-age share, which serves as a proxy for *potential*

labor force participation. An alternative approach is to use workforce shares as a proxy for *realized* labor force participation. Additional analyses show that the effects of population age structure on economic growth are similar when using workforce shares to operationalize labor potential instead of working-age shares (Appendix A.7).

4.3 Predictive Power of the Model

The assessment of the economic effects of foreseeable changes in population age structure requires that our fitted model reasonably predicts economic growth when applied out of sample. We provide evidence supporting the predictive power of our fitted model by testing how well it can predict income per capita growth in within-sample projections. To this end, we partition the data into an estimation sample from 1950 to 1995 for which we fit the model and a projection sample from 2000 to 2015 for which we compute economic growth using the fitted parameters. These within-sample projections show that our fitted model successfully reproduces patterns of economic growth observed in the data: the model correctly captures upward trends in income per capita in OECD and non-OECD countries and matches the observed growth trajectories when it inputs values of working-age shares consistent with population counts in the data (Appendix B.1).

5 From Demographic Dividend to Demographic Drag?

5.1 The Upcoming Demographic Drag

We next investigate the consequences of foreseeable changes in population age structure for future economic growth. To this end, we fit our model to the full sample throughout 1950–2015 and then input demographic predictions into the fitted model to project income per capita in 2020–2050.

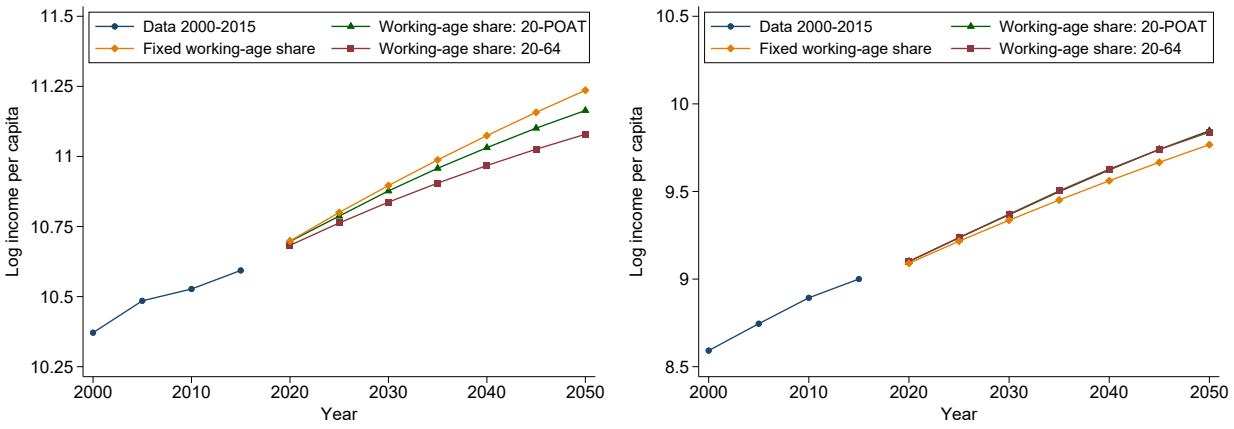
We distinguish among three projection scenarios for income per capita: i) a no-aging scenario in which we counterfactually fix working-age shares at their 2015 level, ii) a retrospective-aging scenario in which working-age shares vary with cohort structure but not with prospective old-age thresholds, and iii) a prospective-aging scenario in which working-age shares vary with both cohort structure and prospective old-age thresholds. In all scenarios, we assign countries a common technological growth trend derived from the time effects and extrapolate their capital stocks with the average accumulation rate in the sample (these assumptions are relaxed in sensitivity analyses). We use projected data on education and population health until 2050, which were derived using state-of-the-art demographic techniques and account for a potential interplay between population aging and human capital (see Lutz et al. 2018; United Nations 2022a, for details). Finally, we fix the quality of economic institutions at 2015 levels.

We estimate the potential effects of changes in working-age shares on economic growth by computing differences in income per capita across scenarios. This approach elicits aging-induced changes in growth of income per capita by varying only population age structure across scenarios. Differences in income per capita between the no-aging and retrospective-aging scenarios reflect the effects of changes in labor potential excluding improvements in functional capacities, whereas differences in income per capita between the no-aging and prospective-aging scenarios reflect the effects of changes in labor potential including improvements in functional capacities. Finally, differences in income per capita between the retrospective-aging and prospective-aging scenarios reflect the effects of changes in labor potential due to improvements in functional capacities.

Figure 3 displays projected income per capita for OECD and non-OECD countries. Contractions in working-age shares will slow economic growth in OECD countries. Compared with the counterfactual no-aging scenario, average annual growth rates of income per capita shrink by 0.8 percentage points if labor potential decreases as predicted by the retrospective-aging scenario (see Appendix B.2 for calculations). However, expansions in labor potential due to people's improved functional capacities could partly offset this slowdown. Compared with the counterfactual no-aging scenario, those growth rates shrink only by 0.4 percentage points if the labor potential decreases as predicted by the prospective-aging scenario, which presumes an average increase in prospective old-age thresholds of 4.5 years in 2020–2050. Hence, perhaps half the projected economic slowdown in OECD countries could be offset if labor potential were to expand with longevity.

Expansions in working-age shares will likely promote economic growth in non-OECD countries. Compared with the counterfactual no-aging scenario, average annual growth rates of income per capita increase by 0.4 percentage points, indicating the opportunity for a demographic dividend. In contrast to OECD countries, projected per capita incomes do not differ appreciably between retrospective and prospective measures of population age structure. This contrast occurs because prospective old-age thresholds across non-OECD countries almost coincide with 64 in 2050 and only exceed it thereafter. Similar results obtain for the average demographic dividend and drag when we group countries with respect to the size of their young-age populations rather than their economic development because the two samples overlap considerably (Appendix B.3).

As OECD and non-OECD averages may mask important heterogeneity in population aging across countries, we next inspect the economic effects of changes in working-age shares at the country level. To this end, we calculate the projected annual growth rates of income per capita in 2020–2050 and compute the corresponding demographic drags and dividends for each country in our sample. Figure 4 charts the results for OECD countries. These estimates constitute bounds for the demographic drags and dividends associated with changes in labor potential under fixed and variable functional capacities, holding cohort structure constant. Differences between these bounds thus indicate the economic gains from expansions in labor potential resulting from improvements in



(a) OECD countries

(b) Non-OECD countries

Figure 3: Projected income per capita

Note: This figure shows projected income per capita for OECD and non-OECD countries in 2020–2050. The projections are based on the parameters estimated in specification (1) of Table 2. The figure contrasts income per capita across three projections predicated on fixed working-age shares (as of 2015), retrospective working-age shares (20–64), and prospective working-age shares (20–POAT), where POAT denotes the age at which remaining life expectancy falls below 15 years.

functional capacities enabled by higher life expectancy.

Almost all OECD countries are predicted to experience an economic slowdown in the upcoming decades. In fact, this demographic drag will be the norm among countries that advance through later stages of the demographic transition: shifts in population age structure are projected to slow economic growth in 70 countries—virtually all the countries in our sample that will see their working-age shares shrink as large cohorts progress to old ages. The intuition behind this result is simple. Time-staggered declines in mortality and fertility and baby booms have created large cohorts that tended to propel economic growth by raising labor quantity and productivity when they entered and passed through working ages. When these large cohorts leave working ages, labor quantity will decline and resources that otherwise could promote productivity will be used for consumption in old age. Without sufficient migration or increases in functional capacities, education, automation, and technological progress to compensate for these effects, a demographic drag follows the demographic dividend.

The extent to which population aging affects economic growth depends not only on how labor potential changes with cohort structure but also on how it evolves as longevity rises. The estimated demographic drag in OECD countries is smaller in the prospective-aging scenario, which incorporates increases in remaining life expectancy, than in the retrospective-aging scenario, which abstracts from them. Although a deceleration in income per capita growth occurs in either scenario, the prospective-aging scenario indicates that the economic consequences of changes in population

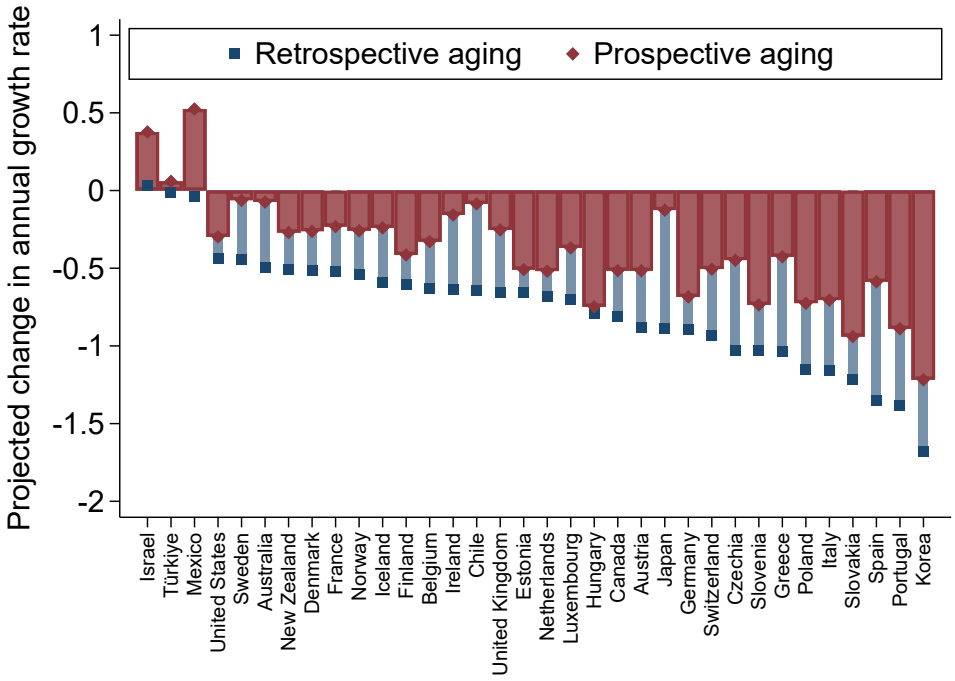


Figure 4: Projected change in annual growth rates for OECD countries

Note: This figure depicts the projected cumulative change in annual growth rates in 2020–2050 in OECD countries. It contrasts the estimated demographic drags and dividends based on the retrospective-aging scenario with the estimated demographic drags and dividends based on the prospective-aging scenario. The projections are predicated on the parameters estimated in specification (1) of Table 2.

age structure will likely be less severe than projections based on cohort structure alone suggest. Hence, application of retrospective measures of population age structure in economic analyses tends to overstate the potential effects of population aging for economic growth.

The differences in projected income per capita between the retrospective-aging and prospective-aging scenarios vary across countries and can be sizable. Under retrospective aging, the annual growth rates of income per capita are projected to decline by 0.89 percentage points (pp) in Japan, 0.64 pp in Chile, and 0.45 pp in Sweden, whereas under prospective aging they are projected to decline only by 0.13 pp in Japan, 0.09 pp in Chile, and 0.06 pp in Sweden. Because remaining life expectancy is comparably high among older people in those countries, most of the demographic drag could be compensated if economic activity expanded into older ages. If, instead, remaining life expectancy is comparably low among older people, only a smaller portion of the demographic drag can be compensated. This case pertains to several countries in Eastern and Southern Europe and to Germany and the Netherlands. Across all OECD countries, up to one-half of the demographic drag could be compensated by changes in labor supply due to improved functional capacity, with projected values for the United States close to this average.

The economic consequences of population aging among non-OECD countries are more mixed than Figure 3 suggests. Shifts in population age structure will create an opportunity for a demographic dividend in countries that are in the early stages of the demographic transition and will likely slow the pace of economic growth in countries whose populations are further advanced in the demographic transition (Appendix B.4). Countries in the early stages of the demographic transition tend to grow faster the faster their populations age and the healthier they are. However, projected income per capita is lower under prospective aging than under retrospective aging, indicating that the window of opportunity for a demographic dividend might be shorter than the retrospective measures of age structure suggest. The labor potential is smaller because average functional capacity is low. Projections based on prospective aging thus appear to provide a more conservative and nuanced estimate of a potential demographic dividend than projections based on retrospective aging.

5.2 Additional Results and Sensitivity Analysis

This section presents results for additional analyses supporting the findings of our baseline projections under alternative assumptions regarding model specifications, capital formation, growth processes, time horizons, and the measurement of labor potential. The results demonstrate that our main findings are insensitive to model choice and the time horizon of our projections.

Alternative specifications of the projection model. The main findings are derived from our baseline model. In additional analyses, we probe the sensitivity of our projection results with respect to more parsimonious and extensive specifications of our projection model. The projections broadly align with our main results and point to a demographic drag in most OECD countries. The baseline and extended models produce a better fit for future growth trajectories than the parsimonious model, while the extended model produces a greater dispersion of growth rates between slow-aging and fast-aging countries than both the baseline and parsimonious models (Appendix B.5).

Calibration of key model parameters. The projections in our main analysis rely on parameters that are estimated with panel data. A potential concern is that the estimates might respond sensitively to changes in the covariates. To rule out the possibility that our measures of population age structure merely absorb the effects of other covariates, we project income per capita with a model in which we calibrate the growth and level effects in line with the parameter restrictions of our conceptual model. The corresponding results confirm our main findings (Appendix B.6).

Shorter time horizons. The long time horizon of our projections raises questions about when shifts in population age structure affect economic growth and whether this timing changes our finding that a demographic drag will be the norm as countries advance through the later stages of

the demographic transition. To address these questions, we separately compute the projected change in annual growth rates of income per capita for OECD countries in 2020–2030 and 2020–2040. The corresponding projections broadly resemble the main results and support the prediction of a future demographic drag (Appendix B.7).

Alternative development paths. The projection analysis uses projected data on population age structure, educational attainment, and life expectancy at birth, relying on the variables' median scenarios. To gauge the extent to which uncertainty about the projected data might influence our projection results, we conducted additional analyses using two alternative development paths: one assuming rapid technological advancement, low population growth, and fast increases in educational attainment and another assuming slow technological growth, high population growth, and slow increases in educational attainment (Appendix B.8). We find broadly similar patterns for the retrospective-aging scenarios as the main analysis, with slightly faster income per capita growth under fast development and slightly slower income per capita growth under slow development. The prospective-aging scenarios characterize bounds on the economic effects of population aging: improvements in functional capacity can fully counteract the demographic drag under fast development, whereas they cannot counteract the demographic drag under slow development at all. Our main results lie in the middle of this range, with the no-aging and retrospective-aging scenarios under the alternative development paths as hypothetical best and worst cases.

Endogenous capital formation. The main analysis abstracts from possible effects of population age structure on capital formation. This assumption reflects an extreme case in which all countries have access to a competitive international capital market in which investment cost and return equalize. On the other extreme, capital accumulation may solely depend on domestic savings, which contract when a significant proportion of the population starts dissaving for retirement. We consider the latter case by computing projections in which we endogenously determine capital formation and iteratively update physical capital stocks and per capita incomes (Appendix B.9). These projections broadly confirm the main findings. If anything, endogenizing capital formation somewhat augments the economic response to shifts in population age structure.

Projections based on workforce shares. Our analysis relies on working-age shares as a proxy for labor potential to project economic growth. Instead, one could use projected workforce shares, though a disadvantage of using the latter is that projections of labor force participation are fraught with uncertainty (International Labour Organization 2021). Nevertheless, the results' sensitivity to the use of workforce shares may be gauged if one is willing to make assumptions about labor force participation in the years ahead. One option is to assume that increasing participation among older

workers balances decreasing overall participation caused by compositional shifts from prime-age to older workers, such that average labor force participation remains constant. The corresponding results show broadly similar patterns as the main analysis (Appendix B.10).

6 Concluding Remarks

As many countries complete the demographic transition, their populations age. While a growing working-age share thanks to aging has been a source of economic growth, contracting working-age shares now threaten to turn the former demographic dividend into a demographic drag.

In this paper, we investigate the consequences of changes in working-age shares for economic growth. We develop an empirical growth model, which we fit to panel data throughout 1950–2015 and then use to project income per capita in 2020–2050. The novelty of our approach lies in the distinction between retrospective and prospective concepts of population age structure, which allows us to gauge the extent to which population aging might slow economic growth as large cohorts pass through to older ages and to determine by how much extensions of labor potential with improvements in functional capacities can counteract this slowdown.

Our findings document that a demographic drag will be the norm in upcoming decades. Contractions in working-age shares will slow economic growth in many countries throughout the world. However, expansions in labor potential due to people's improved functional capacities could offset much of this slowdown. Although migration and technological progress can reduce the demographic drag by cushioning labor shortages, automating physically demanding tasks, and creating age-friendly jobs (Acemoglu and Restrepo 2022; Acemoglu et al. 2022; Abeliansky and Prettner 2023), they will be insufficient to counteract it alone. Against this backdrop, our findings indicate substantial gains for policies that enable older people to remain economically active, including productive nonmarket activities (Bloom et al. 2020). While higher functional capacity tends to increase people's propensity to work full time at older ages, it need not raise labor force participation (Appendix C). Whether such an increase occurs will depend on the extent to which labor markets and health and social policy facilitate retaining workers in the workforce. Potential policies that foster economic activity at older ages include creating incentives for remaining in employment, promoting safe workplaces, providing access to an adequate safety net regarding healthcare and retirement, reducing social inequalities conducive to ill health, and meeting people's needs in dealing with caregiving responsibilities (Berkman et al. 2022). The development of a quantitative framework to analyze the effects of such policies is a natural next step for our research.

We conclude with three cautionary remarks. First, projecting the effects of population age structure on economic growth involves considerable uncertainty. Among other things, it is difficult to reliably predict the occurrences of technological innovations, climate change, pandemics, and war

and their impacts on per capita income and its growth rate. Economic growth may well be slower than in the past (Gordon 2015). Therefore, we view our projections not as forecasts of economic growth but as estimates of the economic implications of global population aging trends based on available information and economic conditions today. Second, our results rely on the assumption that prospective measures of population age structure reflect variation in age-specific functional capacities. While our evidence confirms that this is the case, we cannot rule out the possibility that alternative measures capture this variation more effectively. So far, potential alternatives such as function-based dependency ratios (Skirbekk et al. 2012, 2022) and healthy life expectancy (Vos et al. 2020) do not offer straightforward approaches to modeling the economic gains associated with expansions of labor potential due to changing age patterns of health. How different measures of prospective age structure and functional capacity compare with one another is an avenue for future research. Third, our analysis abstracts from distributional differences in economic activity around old-age thresholds. Because this abstraction accurately represents average functional capacity, it is inconsequential for projected growth of income per capita. Nevertheless, policies aimed at expanding economic activity into older ages can have distributional and related welfare implications. Measuring this effect is a worthwhile area for future research.

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A Additional Results and Robustness of Regression Analysis

A.1 Sample Composition and Descriptive Statistics

Table A.1 lists the countries in our sample and Table A.2 reports descriptive statistics.

Table A.1: Countries in the sample

Country	In OECD (by 2015)	Country	In OECD (by 2015)	Country	In OECD (by 2015)
Albania	—	Georgia	—	Pakistan	—
Algeria	—	Germany	✓	Panama	—
Angola	—	Ghana	—	Paraguay	—
Argentina	—	Greece	✓	Peru	—
Armenia	—	Guatemala	—	Philippines	—
Australia	✓	Guinea-Bissau	—	Poland	✓
Austria	✓	Haiti	—	Portugal	✓
Azerbaijan	—	Honduras	—	Qatar	—
Bahamas	—	Hungary	✓	Republic of Korea	✓
Bahrain	—	Iceland	✓	Republic of Moldova	—
Bangladesh	—	India	—	Romania	—
Belgium	✓	Indonesia	—	Russian Federation	—
Belize	—	Iran	—	Rwanda	—
Benin	—	Ireland	✓	Saudi Arabia	—
Bolivia	—	Israel	✓	Senegal	—
Bosnia & Herzegovina	—	Italy	✓	Serbia	—
Botswana	—	Jamaica	—	Sierra Leone	—
Brazil	—	Japan	✓	Singapore	—
Bulgaria	—	Jordan	—	Slovakia	✓
Burkina Faso	—	Kazakhstan	—	Slovenia	✓
Burundi	—	Kenya	—	South Africa	—
Cabo Verde	—	Kuwait	—	Spain	✓
Cambodia	—	Kyrgyzstan	—	Sri Lanka	—
Cameroon	✓	Latvia	—	Suriname	—
Canada	—	Lebanon	—	Sweden	✓
Central African Republic	—	Lesotho	—	Switzerland	✓
Chad	—	Lithuania	—	Syrian Arab Republic	—
Chile	✓	Luxembourg	✓	Tajikistan	—
China	—	Madagascar	—	Thailand	—
Colombia	—	Malawi	—	Togo	—
Congo	—	Malaysia	—	Trinidad and Tobago	—
Costa Rica	—	Mali	—	Tunisia	—
Côte d'Ivoire	—	Malta	—	Türkiye	✓
Croatia	—	Mauritius	—	Uganda	—
Cyprus	—	Mexico	✓	Ukraine	—
Czechia	✓	Montenegro	—	United Arab Emirates	—
Dem. Rep. of the Congo	—	Mongolia	—	United Kingdom	✓
Denmark	✓	Morocco	—	United Republic of Tanzania	—
Dominican Republic	—	Mozambique	—	United States of America	✓
Ecuador	—	Myanmar	—	Uruguay	—
Egypt	—	Namibia	—	Venezuela	—
El Salvador	—	Nepal	—	Viet Nam	—
Estonia	✓	Netherlands	✓	Yemen	—
Eswatini	—	New Zealand	✓	Zambia	—
Ethiopia	—	Nicaragua	—	Zimbabwe	—
Fiji	—	Niger	—		
Finland	✓	Nigeria	—		
France	✓	North Macedonia	—		
Gabon	—	Norway	✓		
Gambia	—	Oman	—		

Note: This table lists all 145 countries contained in the full sample and their OECD member status.

Table A.2: Descriptive statistics

Variable (units)	Observations	Mean	Standard deviation	Minimum	Maximum
Functional capacity at older ages					
Prospective old-age threshold (in years)	3842	64.57	5.02	50.35	79.00
Life expectancy at age 65 (in years)	4053	14.73	3.28	4.10	26.36
Deficits per person 50–79 (number of deficits)	1086	0.12	0.01	0.10	0.14
Maximum grip strength (in kilograms)	85	33.02	2.12	27.64	36.77
Immediate word recall (number out of 10 words)	89	5.26	0.50	3.61	6.15
Income per capita and capital per worker					
Income per capita growth (in log points)	1340	0.10	0.16	−0.73	0.73
Income per capita in $t-1$ (in log points)	1340	8.86	1.22	5.60	12.23
Growth of capital per worker (in log points)	1340	0.10	0.15	−0.77	1.04
Population age structure, education, and fertility					
Growth of working-age share 20–POAT (in log points)	1340	0.02	0.04	−0.24	0.31
Working-age share 20–POAT in $t-1$ (in log points)	1340	−0.75	0.18	−1.24	−0.19
Growth of workforce share 15–POAT (in log points)	663	0.02	0.05	−0.19	0.24
Workforce share 15–POAT in $t-1$ (in log points)	663	−0.97	0.18	−1.56	−0.32
Growth of working-age share 20–64 (in log points)	1340	0.01	0.03	−0.09	0.17
Working-age share 20–64 in $t-1$ (in log points)	1340	−0.71	0.16	−1.03	−0.20
Growth of workforce share 15–64 (in log points)	663	0.01	0.04	−0.16	0.21
Workforce share 15–64 in $t-1$ (in log points)	663	−0.97	0.17	−1.62	−0.29
Growth of post-primary education (in log points)	1340	0.14	0.11	−0.01	1.05
Post-primary education (in log points)	1340	−1.23	1.07	−7.06	0.00
Change in total fertility rate 20 years ago (in children per woman)	254	−0.77	0.98	−3.57	1.43
Control variables					
Life expectancy at birth (in log points)	1340	4.17	0.18	3.42	4.43
Economic freedom (on scale of 0–10)	1340	6.12	1.27	2.35	8.83
Deficits per working-age person (in log points)	769	−9.22	1.63	−14.37	−4.96
Deficits per working-age person (weighted, in log points)	769	−2.90	0.11	−3.09	−2.61
Disability-adjusted life years (in log points)	772	10.56	0.48	9.66	12.14
Years lived with disability (in log points)	772	9.25	0.16	8.95	9.64
Population size (in log points)	1340	9.22	1.61	5.06	14.15
Young-age ratio (ratio, >0)	1340	90.0	39.4	21.7	182.6
Old-age ratio (ratio, >0)	1340	13.0	7.5	0.2	49.4
Trade openness (in % of GDP)	1340	0.49	0.52	0.00	8.56
Quality of democratic institutions (on scale of 0–1)	1268	0.65	0.35	0.00	1.00
Land area in the tropics (in %)	1278	0.47	0.47	0.00	1.00
Land area within 100 kilometers of coast (in %)	1278	0.38	0.35	0.00	1.00
Ethnic fractionalization (on scale of 0–1)	1315	0.44	0.26	0.00	0.93
Economic activity at older ages					
Propensity to work full time beyond age 62 (in %)	85	0.74	0.17	0.37	1.00
Labor force participation in age group 63–75 (in %)	90	0.11	0.10	0.01	0.60

Note: This table reports descriptive statistics for the full sample of 145 countries. The prospective old-age threshold (POAT) denotes the (country, time-varying) age at which remaining life expectancy falls below 15 years. Income figures refer to gross domestic product (GDP) per capita, measured in international U.S. dollars. Measures for maximum grip strength and immediate word recall refer to averages among the population age 50 and older. Propensity to work full time beyond age 62 measures the population share of people aged 50–62 who state a positive probability of working full time after age 62.

A.2 Parameter Estimates for Covariates in the Main Analysis

Table A.3 shows that the parameter estimates for the covariates in the instrumental variables specifications match the stylized facts in the literature on economic growth. Lagged income per capita correlates negatively with growth over the subsequent five years. According to our estimates, countries converge to their long-run productivity potential at an annual rate of 1.2–2.6 percent, concurring with previous estimates of about 2 percent (Durlauf et al. 2005). Capital accumulation in turn promotes income growth. The estimates document a factor share of approximately one-third. This figure parallels national income accounts data for developed countries (Jones 2016). Human capital boosts growth both as a production factor and as an engine of technological progress (Krueger and Lindahl 2001). Finally, population health and quality of economic institutions predict economic growth (Bloom et al. 2004; Rodrik et al. 2004).

Table A.3: Population age structure affects economic growth: Full results

	Prospective working ages (20–POAT)		Retrospective working ages (20–64)	
Dependent variable: income per capita growth	Uniform growth trends and convergence (2SLS) (1)	Country-specific growth trends and convergence (GMM) (2)	Uniform growth trends and convergence (2SLS) (3)	Country-specific growth trends and convergence (GMM) (4)
Log income per capita ($t-1$)	−0.06***	−0.13***	−0.06***	−0.08***
	(0.02)	(0.06)	(0.02)	(0.03)
Growth of capital per worker	0.32***	0.30***	0.32***	0.32***
	(0.04)	(0.05)	(0.04)	(0.04)
Growth of working-age share	0.79***	0.98***	0.89***	0.92***
	(0.23)	(0.25)	(0.23)	(0.24)
Log working-age share ($t-1$)	0.13*	0.44	0.14**	0.24
	(0.07)	(0.34)	(0.06)	(0.18)
Growth of post-primary education	0.23**	0.17	0.23**	0.23**
	(0.11)	(0.12)	(0.11)	(0.10)
Log post-primary education ($t-1$)	0.03**	0.41	0.03**	0.19
	(0.01)	(0.37)	(0.01)	(0.19)
Log post-primary education ($t-1$) × working-age share ($t-1$)	—	0.15	—	0.07
	—	(0.18)	—	(0.10)
Log post-primary education ($t-1$) × log income per capita ($t-1$)	—	−0.03	—	−0.01
	—	(0.03)	—	(0.02)
Economic freedom	0.03***	0.04***	0.03***	0.04***
	(0.01)	(0.01)	(0.01)	(0.01)
Log life expectancy at birth	0.17**	0.17**	0.18**	0.17**
	(0.07)	(0.08)	(0.07)	(0.07)
First-stage F-statistic	230.2	—	475.3	—
p-value growth effect	0.36	0.92	0.62	0.75
p-value level effect	0.28	0.36	0.19	0.38
AR(1) p-value	—	0.00	—	0.00
AR(2) p-value	—	0.63	—	0.34
Underidentification test p-value	—	0.00	—	0.00
Hansen test p-value	—	0.38	—	0.27
Diff-in-Hansen test p-value	—	0.20	—	0.11
Excluded instruments	1	4	1	4
Countries	145	145	145	145
Observations	1340	1289	1340	1289

Note: This table shows the full set of results for the specifications in Table 2. Estimates are obtained from two-stage least squares (2SLS) and system general method of moments (GMM) for a panel of 145 countries in five-year intervals throughout 1950–2015. All specifications instrument growth of the working-age share with the lagged population share of the age group 15–19. In specifications (1) and (2), the working-age population comprises people in the age range 20–POAT, where POAT denotes the country-specific old-age threshold at which remaining life expectancy falls below 15 years. In specifications (3) and (4), the working-age population comprises people in the age range 20–64. All specifications control for time effects. Specifications (2) and (4) additionally account for country fixed effects by transforming the data with forward orthogonal deviations. The system GMM estimators instrument lagged income per capita using the second lag in the differences equation and the lagged first difference in the levels equation; the specifications use one instrument for each variable rather than for each time period (collapsed instrument set). Tests for serial correlation, underidentification, and overidentification check validity of the identifying assumptions. Standard errors are clustered at the country level and reported in parentheses. Standard errors in GMM specifications are computed with the two-step procedure and corrected for sample size (Windmeijer 2005). Asterisks indicate significance levels: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

A.3 Parsimonious Model Specifications

Table A.4 presents results for parsimonious models that include only changes and levels of working-age shares and lagged income per capita. The estimated growth and level effects in specifications (1) and (3) are larger than our main estimates and exceed the direct effects of population age structure on income per capita implied by our conceptual model. This finding indicates that population age structure has indirect effects on economic growth, which operate through the omitted covariates and are consistent with a demographic dividend and drag. When we account for potential heterogeneity in country growth trends in specifications (2) and (4), the estimated growth and level effects are again similar to those found in our main analysis and align with the parameter restrictions of our conceptual model. Our main results thus do not hinge on the inclusion of specific covariates.

Table A.4: Population age structure and economic growth: Parsimonious model

Dependent variable: income per capita	Prospective working ages (20–POAT)		Retrospective working ages (20–64)	
	(1)	(2)	(3)	(4)
Growth of working-age share	1.46***	1.00***	1.57***	0.95***
	(0.24)	(0.26)	(0.24)	(0.25)
Log of working-age share ($t-1$)	0.43***	0.37***	0.39***	0.32**
	(0.08)	(0.14)	(0.07)	(0.14)
Log income per capita ($t-1$)	−0.05***	−0.16***	−0.04***	−0.15***
	(0.01)	(0.02)	(0.01)	(0.02)
First stage				
Log population share 15–19 ($t-1$)	0.15***	0.19***	0.16***	0.19***
	(0.01)	(0.01)	(0.01)	(0.01)
Reduced form				
Log population share 15–19 ($t-1$)	0.22***	0.19***	0.25***	0.18***
	(0.04)	(0.05)	(0.04)	(0.05)
Country-specific growth trends	—	✓	—	✓
First-stage F-statistic	304.4	345.8	551.2	534.0
p-value growth effect	0.06	1.00	0.02	0.84
p-value level effect	0.00	0.11	0.00	0.22
Countries	145	145	145	145
Observations	1340	1340	1340	1340

Note: This table shows that population age structure affects economic growth. Estimates are obtained from two-stage least squares for a panel of 145 countries in five-year intervals throughout 1950–2015. All specifications instrument growth of the working-age share with the lagged population share of the age group 15–19. In specifications (1) and (2), the working-age population comprises people in the age range 20–POAT, where POAT denotes the country-specific old-age threshold at which remaining life expectancy falls below 15 years. In specifications (3) and (4), the working-age population comprises people in the age range 20–64. All specifications control for time effects. Specifications (2) and (4) additionally include country fixed effects. Standard errors are clustered at the country level and reported in parentheses. Asterisks indicate significance levels: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

A.4 Additional Controls and Calibration of Key Model Parameters

This section presents the results from extended analyses, confirming the robustness of our findings with respect to the inclusion of additional controls for other potential determinants of economic growth and the calibration of select model parameters.

Physiological aging and disability. The prospective working-age share builds on variation in remaining life expectancy to approximate countries' labor potential. This modeling is appropriate if improvements in life expectancy reasonably capture changes in functional capacity (as the evidence in Table 1 suggests). However, a concern might still be that remaining life expectancy primarily accounts for mortality, omitting heterogeneity in functional capacity related to physiological aging and disability that might affect economic growth (see, e.g., Cylus and Al Tayara 2021). We address this concern by separately controlling for average health deficits per working-age person, disability-adjusted life years, and years lived with disability. If disability were to restrict the labor potential and impair economic growth over and above variation captured by remaining life expectancy, the parameter estimates for the working-age share in the main analysis would be biased upward. The results in Tables A.5 and A.6 refute this case. The estimated parameters do not significantly differ from those in the main analysis and match the constraints of our conceptual framework. Moreover, disability does not affect income per capita beyond its effect on working-age shares.

Table A.5: Controlling for average deficits per working-age person

Dependent variable: income per capita growth	Prospective working ages (20–POAT)		Retrospective working ages (20–64)	
	Uniform growth trends and convergence (2SLS) (1)	Country-specific growth trends and convergence (GMM) (2)	Uniform growth trends and convergence (2SLS) (3)	Country-specific growth trends and convergence (GMM) (4)
Panel (a): Deficits per working-age person (20–64)				
Growth of working-age share	1.19***	1.32***	1.31***	1.49***
	(0.32)	(0.40)	(0.31)	(0.42)
Log working-age share ($t-1$)	0.16*	0.53	0.15**	0.38
	(0.09)	(0.58)	(0.07)	(0.34)
Log deficits	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)
First-stage F-statistic	158.6	—	326.7	—
p-value growth effect	0.56	0.43	0.31	0.24
p-value level effect	0.31	0.53	0.25	0.45
AR(1) p-value	—	0.00	—	0.00
AR(2) p-value	—	0.16	—	0.03
Underidentification test p-value	—	0.01	—	0.00
Hansen test p-value	—	0.54	—	0.57
Diff-in-Hansen test p-value	—	0.34	—	0.29
Excluded instruments	1	4	1	4
Countries	144	144	144	144
Observations	769	769	769	769
Panel (b): Deficits per working age person (20–64) weighted by population age structure				
Growth of working-age share	1.21***	1.36***	1.29***	1.49***
	(0.36)	(0.40)	(0.33)	(0.42)
Log working-age share ($t-1$)	0.16*	0.57	0.15*	0.38
	(0.09)	(0.62)	(0.08)	(0.35)
Log deficits	0.01	0.13	−0.01	0.06
	(0.06)	(0.10)	(0.06)	(0.08)
First-stage F-statistic	79.3	—	215.5	—
p-value growth effect	0.56	0.37	0.38	0.24
p-value level effect	0.30	0.53	0.24	0.48
AR(1) p-value	—	0.00	—	0.00
AR(2) p-value	—	0.19	—	0.03
Underidentification test p-value	—	0.03	—	0.00
Hansen test p-value	—	0.63	—	0.58
Diff-in-Hansen test p-value	—	0.37	—	0.30
Excluded instruments	1	4	1	4
Countries	144	144	144	144
Observations	769	769	769	769

Note: This table shows the results' robustness to controlling for physiological aging. Estimates are obtained from two-stage least squares (2SLS) and system general method of moments (GMM) for a panel of 145 countries in five-year intervals throughout 1950–2015. We measure disability by average deficits per working-age person computed from age-specific deficit rates in five-year age groups. Results in panel (a) refer to the unweighted average of deficits, whereas results in panel (b) refer to average deficits weighted by the size of five-year age groups. All specifications instrument growth of the working-age share with the lagged population share of the age group 15–19. In specifications (1) and (2), the working-age population comprises people in the age range 20–POAT, where POAT denotes the country-specific old-age threshold at which remaining life expectancy falls below 15 years. In specifications (3) and (4), the working-age population comprises people in the age range 20–64. All specifications include covariates and control for time effects. Specifications (2) and (4) additionally account for country fixed effects by transforming the data with forward orthogonal deviations. The system GMM estimators instrument lagged income per capita using the second lag in the differences equation and the lagged first difference in the levels equation; the specifications use one instrument for each variable rather than for each time period (collapsed instrument set). Tests for serial correlation, underidentification, and overidentification check validity of the identifying assumptions. Standard errors are clustered at the country level and reported in parentheses. Standard errors in GMM specifications are computed with the two-step procedure and corrected for sample size (Windmeijer 2005). Asterisks indicate significance levels: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table A.6: Controlling for disability-adjusted measures of life loss

Dependent variable: income per capita growth	Prospective working ages (20–POAT)		Retrospective working ages (20–64)	
	Uniform growth trends and convergence (2SLS) (1)	Country-specific growth trends and convergence (GMM) (2)	Uniform growth trends and convergence (2SLS) (3)	Country-specific growth trends and convergence (GMM) (4)
Panel (a): Disability-adjusted life years per 100,000 population				
Growth of working-age share	1.28**	1.32***	1.32***	1.47***
	(0.53)	(0.39)	(0.43)	(0.41)
Log working-age share ($t-1$)	0.17	0.53	0.15**	0.36
	(0.10)	(0.57)	(0.07)	(0.34)
Log DALYs	0.02	0.07	0.00	0.04
	(0.05)	(0.06)	(0.04)	(0.05)
First-stage F-statistic	37.3	—	150.6	—
p-value growth effect	0.60	0.40	0.45	0.25
p-value level effect	0.32	0.52	0.23	0.47
AR(1) *p*-value	—	0.00	—	0.00
AR(2) *p*-value	—	0.17	—	0.03
Underidentification test *p*-value	—	0.02	—	0.00
Hansen test *p*-value	—	0.57	—	0.58
Diff-in-Hansen test *p*-value	—	0.36	—	0.29
Excluded instruments	1	4	1	4
Countries	145	145	145	145
Observations	772	772	772	772
Panel (b): Years lived with disability per 100,000 population				
Growth of working-age share	0.89**	1.32***	1.07***	1.46***
	(0.35)	(0.41)	(0.36)	(0.40)
Log working-age share ($t-1$)	0.18*	0.56	0.18**	0.37
	(0.09)	(0.63)	(0.08)	(0.36)
Log YLDs	−0.08	0.11	−0.07	0.06
	(0.05)	(0.16)	(0.06)	(0.11)
First-stage F-statistic	67.7	—	139.0	—
p-value growth effect	0.76	0.43	0.85	0.25
p-value level effect	0.22	0.55	0.12	0.50
AR(1) *p*-value	—	0.00	—	0.00
AR(2) *p*-value	—	0.20	—	0.03
Underidentification test *p*-value	—	0.08	—	0.00
Hansen test *p*-value	—	0.58	—	0.59
Diff-in-Hansen test *p*-value	—	0.36	—	0.31
Excluded instruments	1	4	1	4
Countries	145	145	145	145
Observations	772	772	772	772

Note: This table shows the results' robustness to controlling for disability. Estimates are obtained from two-stage least squares (2SLS) and system general method of moments (GMM) for a panel of 145 countries in five-year intervals throughout 1950–2015. We measure disability by disability-adjusted years of life (DALYs) per 100,000 population in panel (a) and years lived with disability (YLDs) per 100,000 population in panel (b). All specifications instrument growth of the working-age share with the lagged population share of the age group 15–19. In specifications (1) and (2), the working-age population comprises people in the age range 20–POAT, where POAT denotes the country-specific old-age threshold at which remaining life expectancy falls below 15 years. In specifications (3) and (4), the working-age population comprises people in the age range 20–64. All specifications include covariates and control for time effects. Specifications (2) and (4) additionally account for country fixed effects by transforming the data with forward orthogonal deviations. The system GMM estimators instrument lagged income per capita using the second lag in the differences equation and the lagged first difference in the levels equation; the specifications use one instrument for each variable rather than for each time period (collapsed instrument set). Tests for serial correlation, underidentification, and overidentification check validity of the identifying assumptions. Standard errors are clustered at the country level and reported in parentheses. Standard errors in GMM specifications are computed with the two-step procedure and corrected for sample size (Windmeijer 2005). Asterisks indicate significance levels: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Additional controls. Another potential concern is that our instrumentation does not fully rule out other factors that determine economic growth and correlate with working-age shares. To address this concern, we estimate extended specifications in which we control for additional determinants of growth that previous work in the literature suggests. These specifications account for heterogeneity with respect to population size, young-age and old-age ratios, trade openness, quality of democratic institutions, geography, and ethnic fractionalization. Table A.7 documents that including these determinants neither changes the quantitative findings nor improves the model's fit. By controlling for population composition in terms of young-age and old-age ratios, we explicitly consider that different age groups over the course of the demographic transition may drive variation in working-age shares and that total factor productivity may be lower in societies with large youth or elderly populations due to a smaller pool of researchers and entrepreneurs, increased employment concentration in large firms, and a depressed labor share (Kögel 2005; Aiyar et al. 2016; Aksoy et al. 2019; Hopenhayn et al. 2022; Karahan et al. 2024). Moreover, these controls also indirectly account for the possibility that growing old-age populations might impede economic growth by straining fiscal and health budgets (Lee and Skinner 1999; Bongaarts 2004; Rouzet et al. 2019).

Table A.7: Additional control variables

Dependent variable: income per capita growth	Baseline specification (1)	Population size (2)	Age ratios (3)	Trade openness (4)	Democratic institutions (5)	Geographic controls (6)	Ethnic tensions (7)
Growth of working-age share	0.79***	0.79***	1.43***	0.82***	0.79***	0.93***	0.79***
	(0.23)	(0.23)	(0.49)	(0.23)	(0.24)	(0.25)	(0.23)
Log of working-age share ($t-1$)	0.13*	0.14*	0.34*	0.14*	0.13*	0.09	0.13*
	(0.07)	(0.07)	(0.20)	(0.07)	(0.07)	(0.07)	(0.07)
Log population size	—	0.00	—	—	—	—	—
	—	(0.00)	—	—	—	—	—
Young-age ratio (coefficients × 100)	—	—	0.12	—	—	—	—
	—	—	(0.09)	—	—	—	—
Old-age ratio (coefficients × 100)	—	—	0.39**	—	—	—	—
	—	—	(0.19)	—	—	—	—
Trade openness	—	—	—	0.02**	—	—	—
	—	—	—	(0.01)	—	—	—
Democratic institutions	—	—	—	—	−0.03	—	—
	—	—	—	—	(0.02)	—	—
Percent land area in the tropics	—	—	—	—	—	−0.03**	—
	—	—	—	—	—	(0.01)	—
Percent land area within 100 kilometers of coast	—	—	—	—	—	−0.02	—
	—	—	—	—	—	(0.02)	—
Ethnic fractionalization	—	—	—	—	—	—	−0.01
	—	—	—	—	—	—	(0.02)
First-stage F-statistic	230.2	230.1	57.8	231.8	203.0	195.1	235.6
p-value growth effect	0.36	0.36	0.38	0.44	0.40	0.79	0.38
p-value level effect	0.28	0.27	0.17	0.27	0.31	0.65	0.35
Countries	145	145	145	145	140	138	142
Observations	1340	1340	1340	1340	1268	1278	1315

Note: This table shows the results' robustness to including additional control variables. Estimates are obtained from two-stage least squares for a panel of 145 countries in five-year intervals throughout 1950–2015. All specifications instrument growth of the working-age share with the lagged population share of the age group 15–19. The working-age population comprises people in the age range 20–POAT, where POAT denotes the country-specific old-age threshold at which remaining life expectancy falls below 15 years. Specification (1) replicates the baseline model from Table 2. Specifications (2) to (7) separately control for log population size, young-age and old-age ratios, trade openness, democratic institutions, the percent of land area in the tropics and within 100 kilometers of the coast or navigable rivers, and ethnic fractionalization. Coefficients for the age ratios are multiplied by 100 for illustration. All specifications include covariates and control for time effects. Standard errors are clustered at the country level and reported in parentheses. Asterisks indicate significance levels: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Calibration of select key parameters. Yet another concern might be that the estimates respond sensitively to changes in the covariates. This can happen when the explanatory variables draw on similar variation. We probe the sensitivity of our results by calibrating the effects of population age structure on economic growth with the parameters that our conceptual framework imposes. Specifically, we constrain the growth effect of the working-age share to unity and the level and convergence effects to λ and θ. Table A.8 presents the corresponding parameter estimates for the covariates, which mirror those for our main specifications (reported in Table A.3).

Table A.8: Calibration of economic effects of population age structure

	Prospective working ages (20–POAT)		Retrospective working ages (20–64)	
Dependent variable: income per capita growth	Uniform growth trends and convergence (1)	Country-specific growth trends and convergence (2)	Uniform growth trends and convergence (3)	Country-specific growth trends and convergence (4)
Log income per capita ($t-1$)	−0.06***	−0.09***	−0.06***	−0.09***
	(0.01)	(0.03)	(0.01)	(0.03)
Growth of capital per worker	0.32***	0.29***	0.33***	0.30***
	(0.04)	(0.06)	(0.04)	(0.06)
Growth of post-primary education	0.19*	0.27*	0.20*	0.29*
	(0.10)	(0.15)	(0.11)	(0.15)
Log post-primary education ($t-1$)	0.03**	−0.03	0.03**	−0.03
	(0.01)	(0.10)	(0.01)	(0.09)
Log post-primary education ($t-1$) ×	—	0.00	—	0.00
log income per capita ($t-1$)	—	(0.01)	—	(0.01)
Economic freedom	0.03***	0.05***	0.03***	0.05***
	(0.01)	(0.01)	(0.01)	(0.01)
Log life expectancy at birth	0.19***	0.21**	0.18***	0.17*
	(0.06)	(0.10)	(0.06)	(0.09)
R^2	0.31	—	0.31	—
Within R^2	0.23	—	0.24	—
Countries	145	119	145	119
Observations	1340	1169	1340	1169

Note: This table shows the robustness of the parameter estimates for the main covariates when calibrating the effects of the working-age share in accordance with the parameter constraints of our aggregate production function. The calibration imposes values of unity and λ on the growth and level effects of the working-age share (see equation 7). Estimates are obtained from ordinary least squares for a panel of 145 countries in five-year intervals throughout 1950–2015. In specifications (1) and (2), the working-age population comprises people in the age range 20–POAT, where POAT denotes the country-specific old-age threshold at which remaining life expectancy falls below 15 years. In specifications (3) and (4), the working-age population comprises people in the age range 20–64. All specifications control for time effects. Specifications (2) and (4) further add country fixed effects and use Breitung et al.'s (2022) estimator to correct the mechanical bias arising in dynamic panels with few time periods. Standard errors are clustered at the country level and reported in parentheses. Asterisks indicate significance levels: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

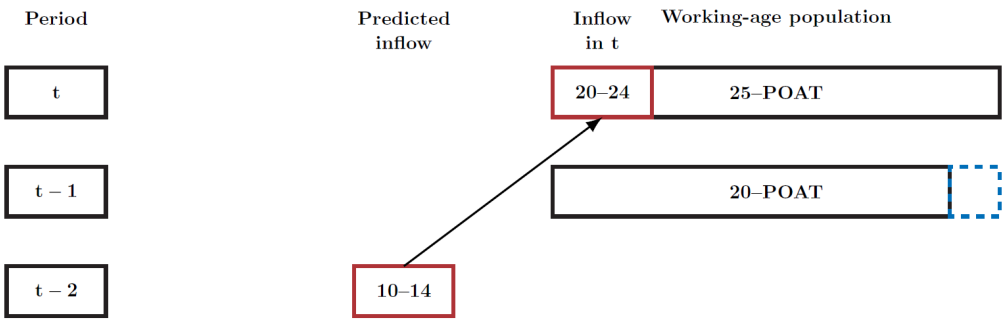
A.5 Robustness of Instrumental Variables Approach

This section presents additional results showing that our findings are robust to different specifications of the instrument sets and an alternative instrumentation strategy based on fertility rates.

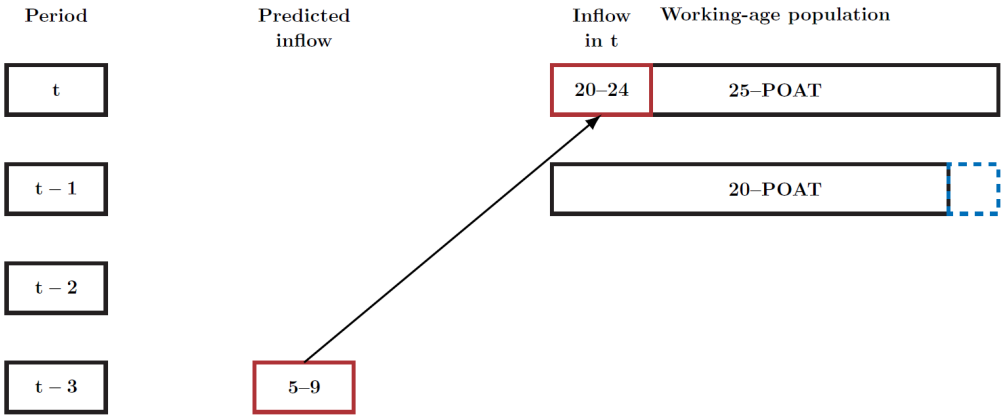
Alternative specifications of instrumental variables. The identification assumption of our empirical strategy requires that unobserved heterogeneity in period t does not causally affect the population shares in previous periods that we use to predict the inflow into working-age shares. This assumption would be violated if people anticipated future productivity shocks and adjusted their behavior such that population age structure changed. While we cannot test this assumption directly, we provide indirect evidence of its plausibility by instrumenting working-age shares with more distant (but still predictive) lags of cohorts that reach working ages in period t. Intuitively, effects of forward-looking behavior are less likely the further an instrument's variation lies in the past. We instrument changes in the working-age share in period t by the population shares of age group 10–14 in $t-2$ (10-year lag), of age group 5–9 in $t-3$ (15-year lag), and of age group 0–4 in $t-4$ (20-year lag): see Figure A.1 for an illustration. Table A.9 shows that the corresponding parameter estimates are similar to those of our main specifications and close to unity with few exceptions, with the results appearing especially stable when accounting for country-specific growth trends and convergence. Furthermore, overidentification tests in specifications that combine all lags do not reject the null hypothesis that these instruments provide the same information.

Predicted outflows from working ages. Another way to indirectly probe the identification assumption is to use the demographic structure to predict the outflow from working ages. To this end, we include the population share aged 60–64 in period $t-1$ as another instrument in our specifications. Table A.10 reports the respective estimates, supporting the main results. However, because prospective old-age thresholds differ across countries and evolve over time, past cohort size can only provide an imprecise classification of working-age status. The predicted outflow from working ages therefore has a much lower accuracy than the predicted inflow into working ages. The results should thus be seen as suggestive.

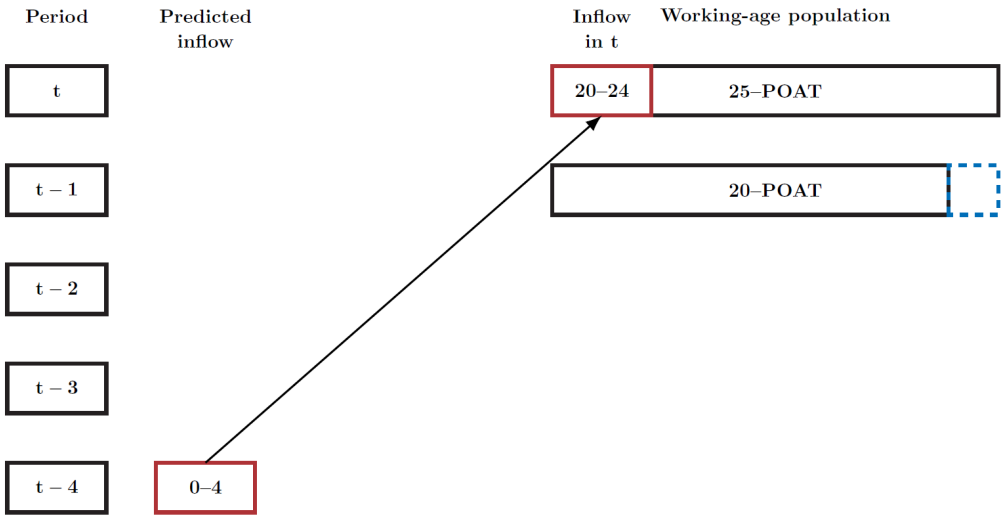
Fertility instruments. Yet another way to examine the robustness of our findings is to use an alternative instrumentation strategy that relies on lagged changes in total fertility rates in long panels. Specifically, we use 20-year lagged changes in total fertility rates as instruments for working-age shares in the following 20-year intervals (e.g., we use changes in fertility rates between 1970 and 1990 to predict changes in working-age shares between 1990 and 2010). The corresponding results in Table A.11 align with our main estimates and are consistent with parameter restrictions of our conceptual framework.



(a) 10-year lags



(b) 15-year lags



(c) 20-year lags

Figure A.1: Instrumentation of the working-age share with more distant lags

Note: This figure illustrates the first stage of our instrumental variables strategy in additional robustness specifications: see Table A.9. Rather than relying on five-year lags of the population share 15–19, these specifications instrument working-age shares with 10-year lags of the population share 10–14, 15-year lags of the population share 5–9, and 20-year lags of the population share 0–4. Working ages (20–POAT) evolve with changes in the prospective old-age threshold over time, which may be positive, negative, or zero and are illustrated by the dashed rectangle.

Table A.9: Results for alternative lag specifications

Dependent variable: income per capita growth	5-year lag (1)	10-year lag (2)	15-year lag (3)	20-year lag (4)	All lags (5)
Panel (a): Prospective working ages: 2SLS					
Growth of working-age share	0.79***	0.62***	0.46*	0.35	0.80***
	(0.23)	(0.23)	(0.23)	(0.26)	(0.24)
First-stage F-statistic	230.2	203.3	194.2	147.7	73.2
p-value growth effect	0.36	0.10	0.02	0.01	0.42
p-value level effect	0.28	0.47	0.80	0.95	0.46
Hansen test *p*-value	—	—	—	—	0.21
Excluded instruments	1	1	1	1	4
Countries	145	145	145	145	145
Observations	1340	1289	1223	1137	1137
Panel (b): Prospective working ages: GMM					
Growth of working-age share	0.98***	0.95***	1.14***	1.12***	0.68***
	(0.25)	(0.27)	(0.35)	(0.43)	(0.24)
p-value growth effect	0.92	0.86	0.69	0.78	0.17
p-value level effect	0.36	0.24	0.32	0.52	0.57
AR(1) *p*-value	0.00	0.00	0.00	0.00	0.00
AR(2) *p*-value	0.63	0.67	0.72	0.69	0.55
Underidentification test *p*-value	0.00	0.00	0.00	0.00	0.00
Hansen test *p*-value	0.38	0.50	0.66	0.42	0.67
Diff-in-Hansen test *p*-value	0.20	0.33	0.36	0.22	0.46
Excluded instruments	4	4	4	4	10
Countries	145	145	145	145	145
Observations	1289	1223	1137	1066	1066
Panel (c): Retrospective working ages: 2SLS					
Growth of working-age share	0.89***	0.75***	0.62***	0.55**	0.87***
	(0.23)	(0.22)	(0.22)	(0.24)	(0.24)
First-stage F-statistic	475.3	464.8	465.7	280.7	109.3
p-value growth effect	0.62	0.25	0.08	0.06	0.59
p-value level effect	0.19	0.29	0.45	0.44	0.25
Hansen test *p*-value	—	—	—	—	0.29
Excluded instruments	1	1	1	1	4
Countries	145	145	145	145	145
Observations	1340	1289	1223	1137	1137
Panel (d): Retrospective working ages: GMM					
Growth of working-age share	0.92***	0.84***	1.09***	1.09***	0.69**
	(0.24)	(0.25)	(0.34)	(0.41)	(0.29)
p-value growth effect	0.75	0.51	0.80	0.83	0.28
p-value level effect	0.38	0.23	0.37	0.60	0.45
AR(1) *p*-value	0.00	0.00	0.00	0.00	0.00
AR(2) *p*-value	0.34	0.37	0.36	0.35	0.38
Underidentification test *p*-value	0.00	0.00	0.00	0.00	0.00
Hansen test *p*-value	0.27	0.29	0.48	0.34	0.62
Diff-in-Hansen test *p*-value	0.11	0.20	0.23	0.16	0.34
Excluded instruments	4	4	4	4	10
Countries	145	145	145	145	145
Observations	1289	1223	1137	1066	1066

Note: This table shows the results' robustness to using alternative lags for instrumentation. Estimates are obtained from two-stage least squares (2SLS) and system general method of moments (GMM) for a panel of 145 countries in five-year intervals throughout 1950–2015. The specifications instrument growth of the working-age share with the lagged population share of age group 15–19 (1), the second lag of the population share of age group 10–14 (2), the third lag of the population share of age group 5–9 (3), the fourth lag of the population share of age group 0–4 (4), and all four lags together (5). In panels (a) and (b), the working-age population comprises people in the age range 20–POAT, where POAT denotes the country-specific old-age threshold at which remaining life expectancy falls below 15 years. In panels (c) and (d), the working-age population comprises people in the age range 20–64. All specifications include covariates and control for time effects. GMM specifications additionally account for country fixed effects by transforming the data with forward orthogonal deviations. The system GMM estimators instrument lagged income per capita using the second lag in the differences equation and the lagged first difference in the levels equation; the specifications use one instrument for each variable rather than for each time period (collapsed instrument set). Tests for serial correlation, underidentification, and overidentification check validity of the identifying assumptions. Standard errors are clustered at the country level and reported in parentheses. Standard errors in GMM specifications are computed with the two-step procedure and corrected for sample size (Windmeijer 2005). Asterisks indicate significance levels: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table A.10: Instrumentation with predicted inflow into and outflow from the working-age share

	Prospective working ages (20–POAT)		Retrospective working ages (20–64)	
Dependent variable: income per capita growth	Uniform growth trends and convergence (2SLS) (1)	Country-specific growth trends and convergence (GMM) (2)	Uniform growth trends and convergence (2SLS) (3)	Country-specific growth trends and convergence (GMM) (4)
Growth of working-age share	0.67***	1.01***	0.71***	1.00***
	(0.22)	(0.26)	(0.21)	(0.25)
Log working-age share ($t-1$)	0.12*	0.44	0.13**	0.25
	(0.07)	(0.31)	(0.06)	(0.21)
First-stage F-statistic	122.3	—	269.7	—
p-value growth effect	0.13	0.97	0.18	0.99
p-value level effect	0.35	0.32	0.25	0.39
AR(1) p-value	—	0.00	—	0.00
AR(2) p-value	—	0.68	—	0.36
Underidentification test p-value	—	0.00	—	0.00
Hansen test p-value	0.03	0.07	0.04	0.11
Diff-in-Hansen test p-value	—	0.13	—	0.08
Excluded instruments	2	6	2	6
Countries	145	145	145	145
Observations	1340	1289	1340	1289

Note: This table shows that the working-age share affects economic growth when using both the predicted inflow into and outflow from the working-age share as instruments. Estimates are obtained from two-stage least squares (2SLS) and system general method of moments (GMM) for a panel of 145 countries in five-year intervals throughout 1950–2015. All specifications instrument growth of the working-age share with the lagged population shares of the age groups 15–19 and 60–64. In specifications (1) and (2), the working-age population comprises people in the age range 20–POAT, where POAT denotes the country-specific old-age threshold at which remaining life expectancy falls below 15 years. In specifications (3) and (4), the working-age population comprises people in the age range 20–64. All specifications include covariates and control for time effects. Specifications (2) and (4) additionally account for country fixed effects by transforming the data with forward orthogonal deviations. The system GMM estimators instrument lagged income per capita using the second lag in the differences equation and the lagged first difference in the levels equation; the specifications use one instrument for each variable rather than for each time period (collapsed instrument set). Tests for serial correlation, underidentification, and overidentification check validity of the identifying assumptions. Standard errors are clustered at the country level and reported in parentheses. Standard errors in GMM specifications are computed with the two-step procedure and corrected for sample size (Windmeijer 2005). Asterisks indicate significance levels: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table A.11: Fertility instruments in 20-year panels

Dependent variable: income per capita	Prospective working ages (20–POAT) (1)	Retrospective working ages (20–64) (2)
Growth of working-age share	1.39***	1.28***
	(0.46)	(0.44)
Log working-age share ($t-1$)	0.71*	0.58
	(0.39)	(0.38)
First stage		
Change in total fertility rate ($t-1$)	−0.04***	−0.05***
	(0.01)	(0.01)
Reduced form		
Change in total fertility rate ($t-1$)	−0.08***	−0.08***
	(0.02)	(0.02)
First-stage F-statistic	70.8	82.7
p-value growth effect	0.40	0.53
p-value level effect	0.17	0.30
Countries	145	145
Observations	242	242

Note: This table shows that population age structure affects economic growth. Estimates are obtained from two-stage least squares for a panel of 145 countries in 20-year intervals throughout 1970–2010. All specifications instrument growth of the working-age share with the 20-year lagged difference in the total fertility rate obtained from the United Nations World Population Prospects (United Nations 2024). In specification (1), the working-age population comprises people in the age range 20–POAT, where POAT denotes the country-specific old-age threshold at which remaining life expectancy falls below 15 years. In specification (2), the working-age population comprises people in the age range 20–64. All specifications include covariates and control for time effects. Standard errors are clustered at the country level and reported in parentheses. Asterisks indicate significance levels: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

A.6 Parameter Stability across Samples and Panel Intervals

Work on the demographic dividend implicitly assumes that the effects of population age structure on economic growth are stable across countries and over time. To examine this stability assumption, we reproduce the results of Table 2 for 10-year panel intervals (Table A.12) and re-estimate specifications (1) and (2) separately for OECD and non-OECD countries, and for abridged samples covering the periods 1950–2000 and 1965–2015 (Tables A.13 and A.14). The results confirm that the effects of population age structure on economic growth are indeed stable across samples.

Table A.12: Estimation with longer time horizons: 10-year panel intervals

	Prospective working ages (20–POAT)		Retrospective working ages (20–64)	
Dependent variable: income per capita growth	Uniform growth trends and convergence (2SLS) (1)	Country-specific growth trends and convergence (GMM) (2)	Uniform growth trends and convergence (2SLS) (3)	Country-specific growth trends and convergence (GMM) (4)
Growth of working-age share	1.21***	1.31***	1.18***	1.25***
	(0.36)	(0.33)	(0.28)	(0.37)
Log working-age share ($t-1$)	0.37**	1.20	0.33**	0.68*
	(0.17)	(0.75)	(0.14)	(0.40)
First stage				
Log population share 10–14 ($t-1$)	0.20***	—	0.30***	—
	(0.02)	—	(0.02)	—
Reduced form				
Log population share 10–14 ($t-1$)	0.24***	—	0.35***	—
	(0.07)	—	(0.08)	—
First-stage F-statistic	64.7	—	221.0	—
p-value growth effect	0.56	0.34	0.51	0.50
p-value level effect	0.12	0.23	0.10	0.23
AR(1) p-value	—	0.00	—	0.00
AR(2) p-value	—	0.29	—	0.30
Underidentification test p-value	—	0.02	—	0.00
Hansen test p-value	—	0.85	—	0.91
Diff-in-Hansen test p-value	—	0.85	—	0.86
Excluded instruments	1	4	1	4
Countries	145	145	145	145
Observations	589	538	589	538

Note: This table shows that population age structure affects economic growth. Estimates are obtained from two-stage least squares (2SLS) and system general method of moments (GMM) for a panel of 145 countries in 10-year intervals throughout 1950–2010. All specifications instrument growth of the working-age share with the lagged population share of the age group 10–14. In specifications (1) and (2), the working-age population comprises people in the age range 20–POAT, where POAT denotes the country-specific old-age threshold at which remaining life expectancy falls below 15 years. In specifications (3) and (4), the working-age population comprises people in the age range 20–64. All specifications include covariates and control for time effects. Specifications (2) and (4) additionally account for country fixed effects by transforming the data with forward orthogonal deviations. The system GMM estimators instrument lagged income per capita using the second lag in the differences equation and the lagged first difference in the levels equation; the specifications use one instrument for each variable rather than for each time period (collapsed instrument set). Tests for serial correlation, underidentification, and overidentification check validity of the identifying assumptions. Standard errors are clustered at the country level and reported in parentheses. Standard errors in GMM specifications are computed with the two-step procedure and corrected for sample size (Windmeijer 2005). Asterisks indicate significance levels: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table A.13: The economic effects of age structure are stable across samples: Baseline model

Dependent variable: income per capita growth	Full sample (1)	OECD countries (2)	Non-OECD countries (3)	Sample 1950–2000 (4)	Sample 1965–2015 (5)
Growth of working-age share	0.79***	0.95***	0.57*	1.00***	0.72***
	(0.23)	(0.34)	(0.33)	(0.31)	(0.23)
Log working-age share ($t-1$)	0.13*	0.22***	0.10	0.21**	0.10
	(0.07)	(0.08)	(0.08)	(0.09)	(0.07)
First-stage F-statistic	230.2	102.8	97.4	129.3	240.9
p-value growth effect	0.36	0.89	0.20	1.00	0.23
p-value level effect	0.28	0.16	0.55	0.07	0.56
Countries	145	34	111	123	145
Observations	1340	399	941	915	1223

Note: This table shows the stability of the effects of population age structure on economic growth across samples. The estimates are obtained from two-stage least squares for a panel of 145 countries in five-year intervals throughout the period 1950–2015. All specifications instrument growth of the working-age share with the lagged population share of the age group 15–19. The working-age population comprises people in the age range 20–POAT, where POAT denotes the country-specific old-age threshold at which remaining life expectancy falls below 15 years. The table shows results for the full sample (1), OECD countries (2), non-OECD countries (3), and abridged samples spanning the periods 1950–2000 (4) and 1965–2015 (5). All specifications include covariates and control for time effects. Standard errors are clustered at the country level and reported in parentheses. Asterisks indicate significance levels: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table A.14: The economic effects of age structure are stable across samples: Extended model

Dependent variable: income per capita growth	Full sample (1)	OECD countries (2)	Non-OECD countries (3)	Sample 1950–2000 (4)	Sample 1965–2015 (5)
Growth of working-age share	0.98***	1.19***	1.12	1.07***	0.92***
	(0.25)	(0.30)	(0.74)	(0.25)	(0.26)
Log working-age share ($t-1$)	0.44	0.60**	1.20	0.54**	0.42
	(0.34)	(0.30)	(1.26)	(0.26)	(0.36)
p-value growth effect	0.92	0.52	0.87	0.77	0.76
p-value level effect	0.36	0.23	0.47	0.13	0.42
AR(1) p-value	0.00	0.01	0.00	0.00	0.00
AR(2) p-value	0.63	0.93	0.93	0.70	0.64
Underidentification test p-value	0.00	0.01	0.31	0.00	0.00
Hansen test p-value	0.38	0.16	0.76	0.92	0.43
Diff-in-Hansen test p-value	0.20	0.12	0.85	0.84	0.22
Countries	145	34	111	123	145
Observations	1289	374	915	864	1223

Note: This table shows the stability of the effects of population age structure on economic growth across samples. The estimates are obtained from system general method of moments for a panel of 145 countries in five-year intervals throughout 1950–2015. The table shows results for the full sample (1), OECD countries (2), non-OECD countries (3), and abridged samples covering the periods 1950–2000 (4) and 1965–2015 (5). All specifications include covariates and control for time and country fixed effects. They instrument growth of the working-age share with the lagged population share of the age group 15–19 in the differences equation and with the lagged first difference of this share in the levels equation. The estimators instrument lagged income per capita using the second lag in the differences equation and the lagged first difference for instrumentation in the levels equation; the specifications use one instrument for each variable rather than for each time period (collapsed instrument set). Tests for serial correlation, underidentification, and overidentification check validity of the identifying assumptions. Standard errors are computed with the two-step procedure, corrected for sample size (Windmeijer 2005), and reported in parentheses. Asterisks indicate significance levels: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

A.7 Workforce Shares as an Alternative Measure for Labor Potential

In the main analysis, we measure countries' labor potentials with working-age rather than workforce shares because labor force participation tends to correlate with productivity over the business cycle. To test whether our findings hinge on this measurement choice, we construct workforce shares from population counts and data on labor force participation, which are available from 1990 onward (reducing sample size by about half). For reasons of data availability, we focus on the population aged 15 and older. Table A.15 shows that estimates predicated on workforce shares are quantitatively similar to those based on working-age shares. According to the model with uniform growth trends and convergence, a 1 percent increase in the workforce share (about 0.4 percentage points) raises income per capita by 1 percent. The corresponding parameters for the models with country-specific growth trends and convergence are larger but less precise and not significantly different from unity. Estimates for the lagged workforce share are positive but only significant when country-specific growth trends and convergence are considered.

Table A.15: Population age structure affects economic growth: Estimates based on workforce shares

	Prospective working ages (20–POAT)		Retrospective working ages (20–64)	
Dependent variable: income per capita growth	Uniform growth trends and convergence (2SLS) (1)	Country-specific growth trends and convergence (GMM) (2)	Uniform growth trends and convergence (2SLS) (3)	Country-specific growth trends and convergence (GMM) (4)
Growth of workforce share	1.03**	1.94***	0.96***	2.06***
	(0.42)	(0.67)	(0.36)	(0.75)
Log workforce share ($t-1$)	0.00	0.41**	0.03	0.25*
	(0.04)	(0.20)	(0.04)	(0.13)
First stage				
Log population share 10–14 ($t-1$)	0.07***	—	0.09***	—
	(0.01)	—	(0.01)	—
Reduced form				
Log population share 10–14 ($t-1$)	0.07**	—	0.08***	—
	(0.03)	—	(0.03)	—
First-stage F-statistic	39.1	—	69.7	—
p-value growth effect	0.95	0.16	0.91	0.16
p-value level effect	0.11	0.38	0.25	0.45
AR(1) p-value	—	0.00	—	0.00
AR(2) p-value	—	0.04	—	0.02
Underidentification test p-value	—	0.02	—	0.01
Hansen test p-value	—	0.87	—	1.00
Diff-in-Hansen test p-value	—	0.91	—	0.99
Excluded instruments	1	4	1	4
Countries	145	145	145	145
Observations	663	663	663	663

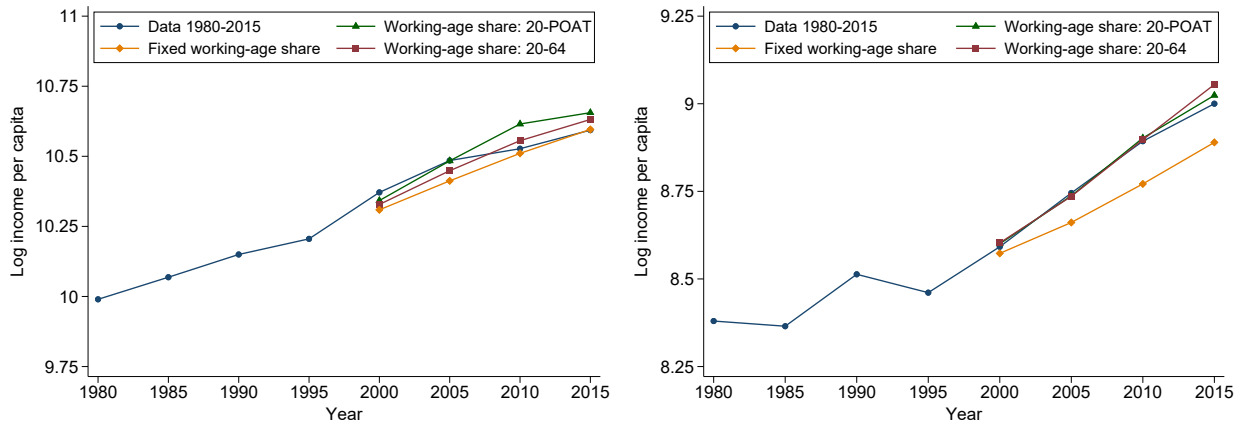
Note: This table shows the results' robustness for specifications that measure population age structure with the workforce share. Estimates are obtained from two-stage least squares (2SLS) and system general method of moments (GMM) for a panel of 145 countries in five-year intervals throughout 1950–2015. The workforce share is computed by multiplying the working-age population by the average labor force participation rate of the population age 15 and older. All specifications instrument growth of the workforce share with the lagged population share of the age group 10–14. In specifications (1) and (2), the working-age population comprises people in the age range 15–POAT, where POAT denotes the country-specific old-age threshold at which remaining life expectancy falls below 15 years. In specifications (3) and (4), the working-age population comprises people in the age range 15–64. All specifications include covariates and control for time effects. Specifications (2) and (4) additionally account for country fixed effects by transforming the data with forward orthogonal deviations. The system GMM estimators instrument lagged income per capita using the second lag in the differences equation and the lagged first difference in the levels equation; the specifications use one instrument for each variable rather than for each time period (collapsed instrument set). Tests for serial correlation, underidentification, and overidentification check validity of the identifying assumptions. Standard errors are clustered at the country level and reported in parentheses. Standard errors in GMM specifications are computed with the two-step procedure and corrected for sample size (Windmeijer 2005). Asterisks indicate significance levels: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

B Additional Results and Sensitivity of Projection Analysis

B.1 Predictive Power of the Model

The assessment of the economic effects of foreseeable changes in population age structure requires that our fitted model reasonably predicts economic growth when applied out of sample. We provide evidence supporting the predictive power of our fitted model by testing how well it can predict income per capita growth in within-sample projections. To this end, we partition the data into an estimation sample from 1950 to 1995 for which we fit the model and a projection sample from 2000 to 2015 for which we compute economic growth using the fitted parameters.

We distinguish among three projection scenarios for income per capita: i) a no-aging scenario in which we counterfactually fix working-age shares at their 1995 level, ii) a retrospective-aging scenario in which working-age shares vary with cohort structure but not with prospective old-age thresholds, and iii) a prospective-aging scenario in which working-age shares vary with both cohort structure and prospective old-age thresholds. In all scenarios, we assign each country the technological growth rate at the frontier and assume capital accumulation, education, population health, and institutional quality follow country-specific trajectories in the data. By only varying population age structure across scenarios, the projections shed light on the model's capability to predict aging-induced changes in economic growth.



(a) OECD countries

(b) Non-OECD countries

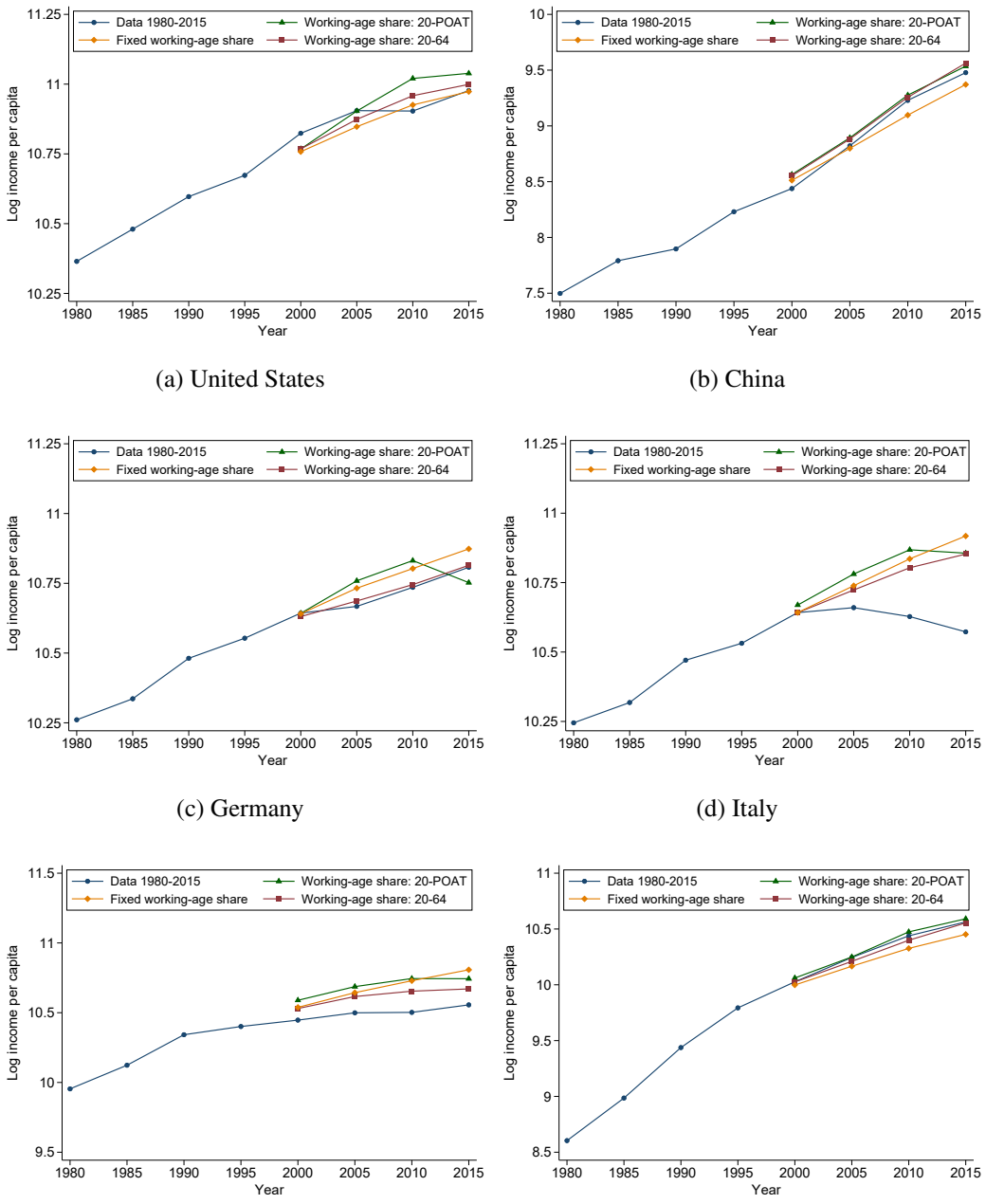
Figure B.1: Predictive power of the model for OECD and non-OECD countries: 2000–2015

Note: This figure compares observed and projected income per capita for OECD and non-OECD countries in 2000–2015. The projections are based on parameters derived from estimating specification (1) of Table 2 over an abridged sample 1950–1995. The figure compares observed income per capita with three projections predicated on fixed working-age shares (as of 1995), retrospective working-age shares (20–64), and prospective working-age shares (20–POAT), where POAT denotes the age at which remaining life expectancy falls below 15 years.

Figure B.1 compares observed and projected economic growth in OECD and non-OECD countries. The within-sample projections show that the fitted model correctly captures upward trends in income per capita and matches the observed growth trajectories when it injects values of working-age shares consistent with population counts in the data. If anything, the projected values slightly exceed the observed ones after the productivity shock of the 2007–2008 financial crisis. The results do not differ appreciably between the retrospective-aging and prospective-aging scenarios as both trended similarly in 1995–2015.

Notably, the fitted model understates income per capita in the no-aging benchmark when compared with the data for non-OECD countries. This gap reveals that shifts in working-age shares yielded an average demographic dividend worth 10 percent of income per capita in 2000–2015. We find no such dividend for OECD countries because average working-age shares barely changed over this period. These differences indicate that the model successfully traces the economic effects of changes in population age structure. Moreover, they rule out the possibility that projected and observed income per capita solely match because we impose common technological trends on all countries. If this were the case, economic growth in OECD and non-OECD countries should mirror one another.

Figure B.2 shows that the fitted model also predicts economic growth at the country level. For instance, projected per capita incomes match the observed ones in the United States and China. This consistency corroborates the model's capability to reproduce growth patterns at different development stages: starting from a lower level, China has grown about five times faster than the United States over this period. The projections further match economic growth in other aging economies such as Germany, Japan, and the Republic of Korea. In contrast, the model cannot predict the economic stagnation in Italy, where total factor productivity and competitiveness have stalled for structural reasons that are unrelated to population aging (Pellegrino and Zingales 2019). However, while such country-specific trends may provide an inaccurate characterization of income per capita levels, they do not impair estimation of the economic effects of shifts in working-age shares, which we derive from income differences across projection scenarios that partial out these trends.



(a) United States

(b) China

(c) Germany

(d) Italy

(e) Japan

(f) Korea

Figure B.2: Predictive power of the model for selected countries: 2000–2015

Note: This figure compares observed and projected income per capita for selected countries in 2000–2015. The projections are based on parameters derived from estimating specification (1) of Table 2 for an abridged sample 1950–1995. The figure compares observed income per capita with three projections predicated on fixed working-age shares (as of 1995), retrospective working-age shares (20–64), and prospective working-age shares (20–POAT), where POAT denotes the age at which remaining life expectancy falls below 15 years.

B.2 Calculation of Predicted Annual Growth Rates of Income per Capita

The annual growth rates between 2020 and 2050 for each projection scenario $j \in \{1,2,3\}$ are computed according to

$$\widehat{g}_j \approx (100/30) \cdot \left(e^{\widehat{y}_j^{2050}} - e^{\widehat{y}_j^{2020}} \right) / e^{\widehat{y}_j^{2020}},$$

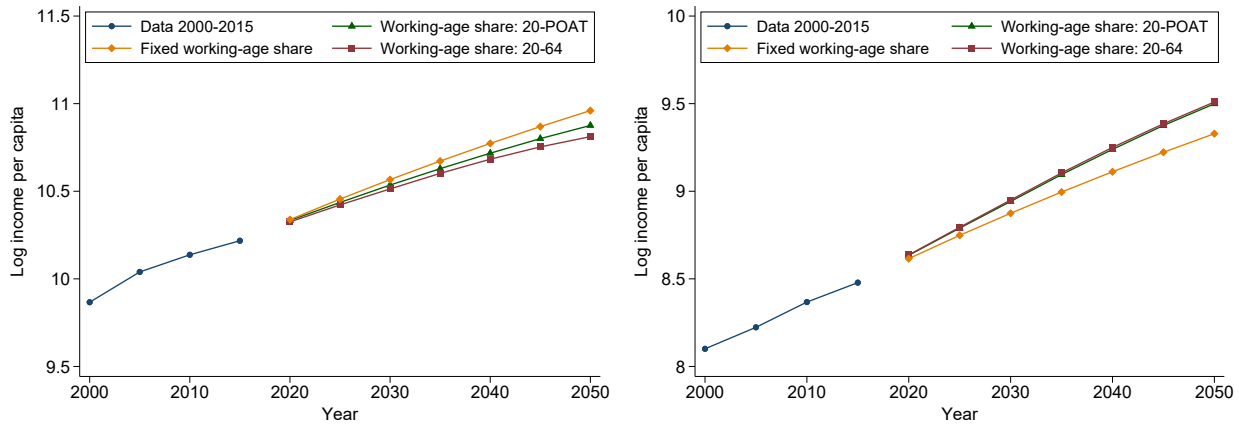
where $\widehat{y}_j^{2020}$ and $\widehat{y}_j^{2050}$ denote projected log income per capita in 2020 and 2050. The demographic drag (or dividend) is then calculated as the difference in growth rates between the corresponding aging and no-aging scenarios. For example, the demographic drag under the retrospective-aging scenario is derived by

$$\widehat{DD} = (100/30) \cdot \left[\left(e^{11.24} - e^{10.70} \right) / e^{10.70} - \left(e^{11.08} - e^{10.70} \right) / e^{10.70} \right] \approx 0.8.$$

The demographic drag under the prospective-aging scenario is analogously derived by

$$\widehat{DD} = (100/30) \cdot \left[\left(e^{11.24} - e^{10.70} \right) / e^{10.70} - \left(e^{11.16} - e^{10.70} \right) / e^{10.70} \right] \approx 0.4.$$

B.3 Countries with Small vs. Large Young-Age Populations



(a) Small young-age population

(b) Large young-age population

Figure B.3: Projected income per capita for countries with small and large young-age populations

Note: This figure shows projected income per capita for countries with small and large young-age populations in 2020–2050, where the sample is split along the median of the young-age ratio in 2015. The projections are based on the parameters estimated in specification (1) of Table 2. The figure contrasts income per capita across three projections predicated on fixed working-age shares (as of 2015), retrospective working-age shares (20–64), and prospective working-age shares (20–POAT), where POAT denotes the age at which remaining life expectancy falls below 15 years.

B.4 Projected Demographic Dividends and Drags in Non-OECD Countries

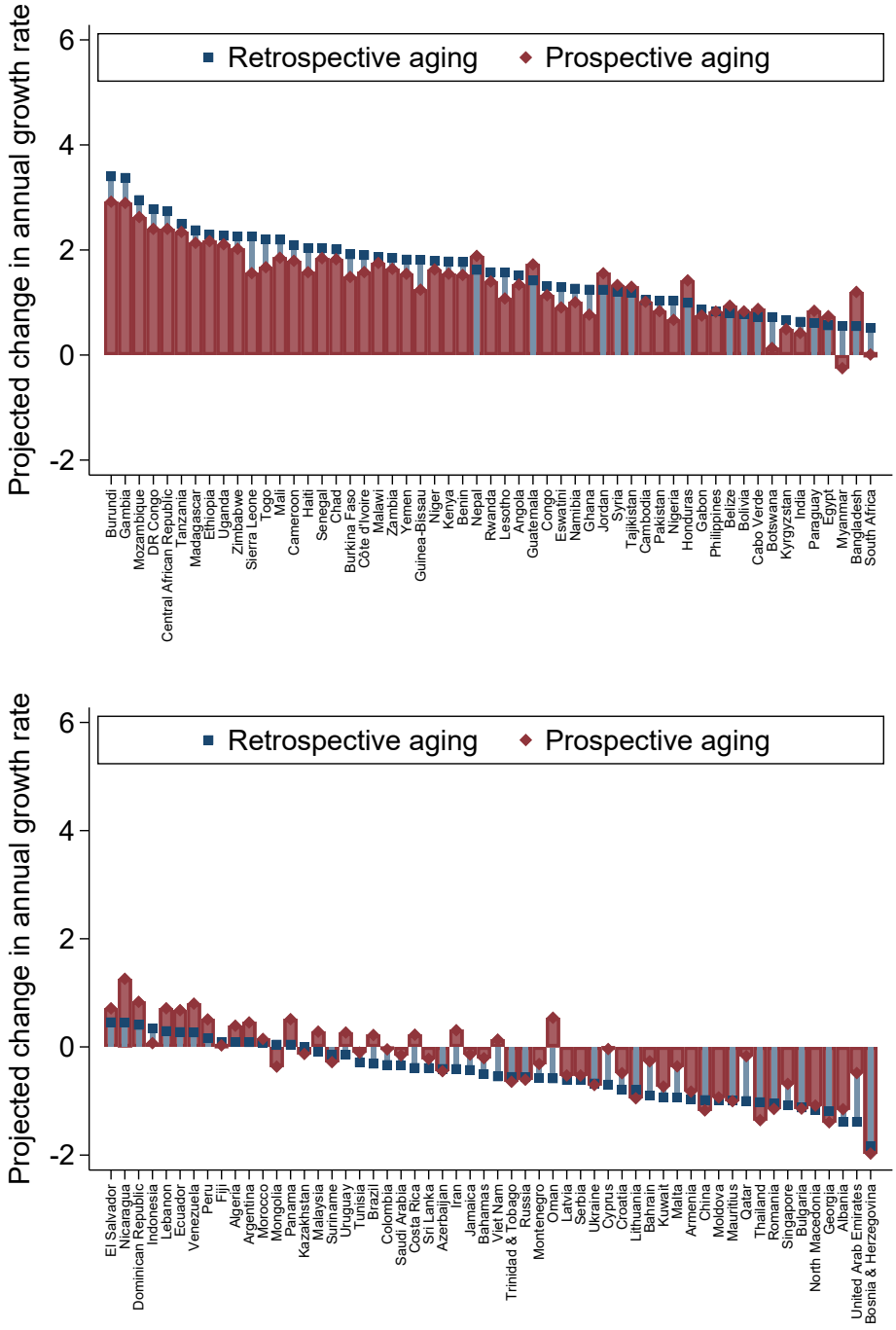


Figure B.4: Projected change in annual growth rates in non-OECD countries

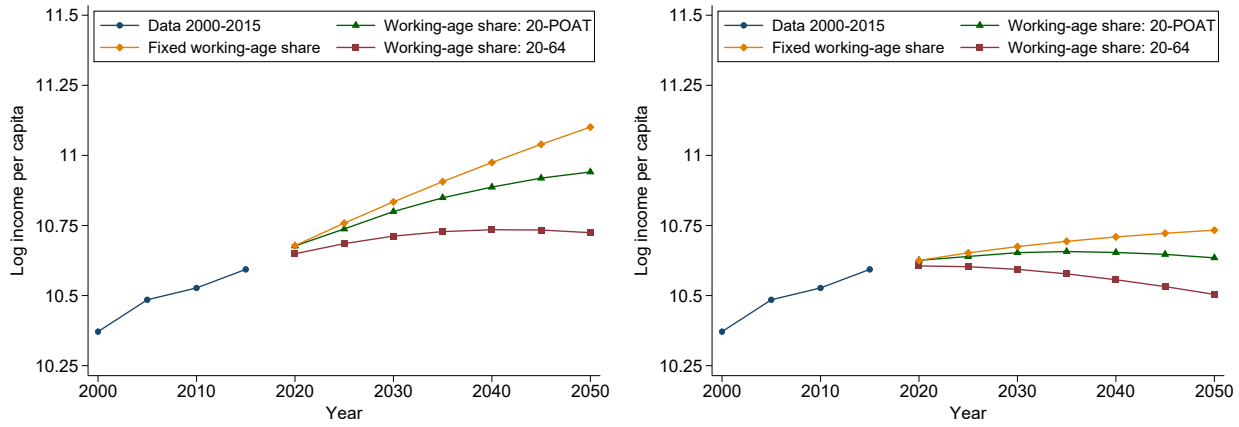
Note: This figure depicts the projected cumulative change in annual growth rates in 2020–2050 in non-OECD countries. It contrasts the estimated demographic drags and dividends based on the retrospective-aging scenario with estimated demographic drags and dividends based on the prospective-aging scenario. The projections are predicated on the parameters estimated in specification (1) of Table 2.

B.5 Alternative Specifications of the Projection Model

This section examines the sensitivity of our projection results with respect to alternative specifications of the projection model.

Parsimonious model. Our main findings are derived from the baseline model, which is theoretically grounded in the conceptual framework in Section 3.1. We test the sensitivity of this model against the projection results for parsimonious models with minimal covariates that capture both the direct and indirect effects of shifts in population age structure on economic growth (for regression results, see Appendix A.3). The corresponding projections in Figures B.5 and B.6 broadly align with those for our baseline model. Regarding the future growth trajectories, the parsimonious model's fit appears worse than that of the baseline model, which is unsurprising because the parsimonious model does not include other covariates that could moderate the influences of shifts in population age structure on economic growth. However, once the parsimonious model accounts for heterogeneity in country growth trends, it predicts similar aging-induced changes in annual growth rates for OECD countries as the baseline model (Figure B.5, Panel b).

Extended model. For the projections in our main analysis, we assume that all countries follow a common growth trend to isolate variation in future income per capita related to demographic change. Our findings do not hinge on this assumption. Because the growth trend is the same across all projection scenarios, the estimated economic ramifications of population aging should be preserved even if countries follow different growth paths. We test this conjecture by projecting income per capita based on our extended model that allows for country-specific growth trends and convergence (for regression results, see Table 2). The projections in Figures B.7 and B.8 show similar patterns as our main analysis, with a slightly higher dispersion in growth rates between slow-aging and fast-aging countries.

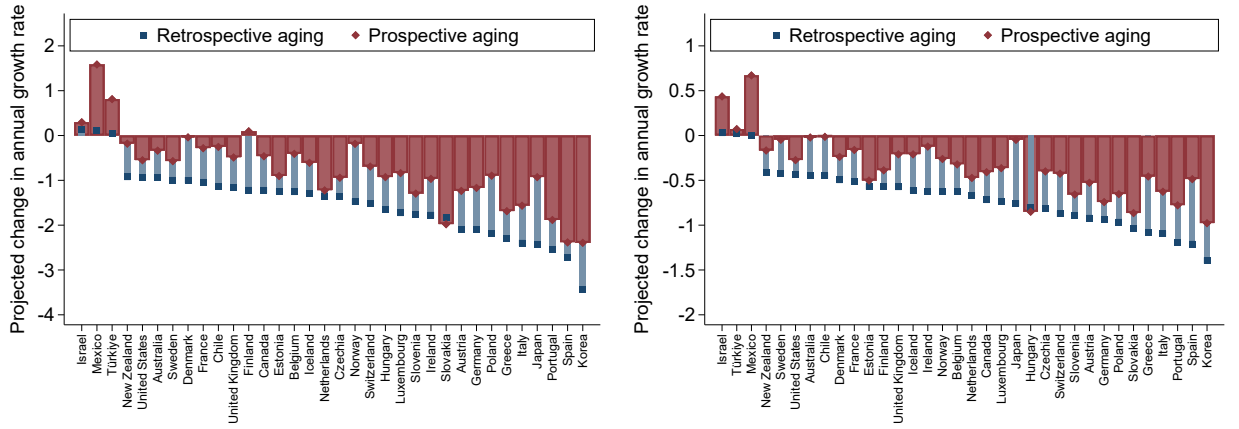


(a) Without country-specific growth trends

(b) With country-specific growth trends

Figure B.5: Projected income per capita: Parsimonious model

Note: This figure shows projected income per capita for OECD countries in 2020–2050. The projections are based on the parameters in specification (1) of Table A.4 in Panel (a) and on the parameters in specification (2) of Table A.4 in Panel (b). The figure contrasts income per capita across three projections predicated on fixed working-age shares (as of 2015), retrospective working-age shares (20–64), and prospective working-age shares (20–POAT), where POAT denotes the age at which remaining life expectancy falls below 15 years.

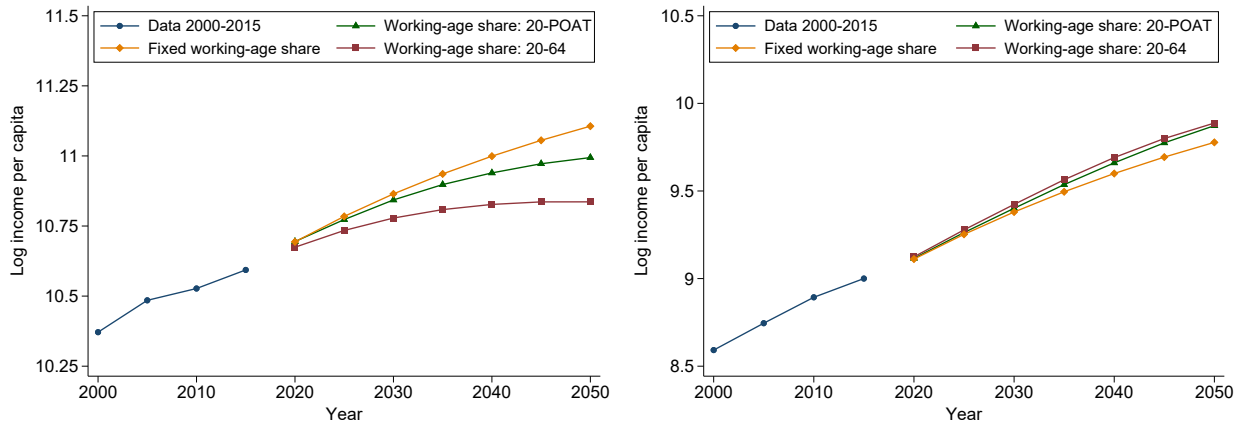


(a) Without country-specific growth trends

(b) With country-specific growth trends

Figure B.6: Projected change in annual growth rates: Parsimonious model

Note: This figure depicts the projected cumulative change in annual growth rates in 2020–2050 in OECD countries. It contrasts the estimated demographic drags and dividends based on the retrospective-aging scenario with the estimated demographic drags and dividends based on the prospective-aging scenario. The projections are based on the parameters in specification (1) of Table A.4 in Panel (a) and on the parameters in specification (2) of Table A.4 in Panel (b).



(a) OECD countries

(b) Non-OECD countries

Figure B.7: Projected income per capita: Extended model

Note: This figure shows projected income per capita for OECD and non-OECD countries in 2020–2050. The projections are based on the parameters estimated in specification (2) of Table 2. The figure contrasts income per capita across three projections predicated on fixed working-age shares (as of 2015), retrospective working-age shares (20–64), and prospective working-age shares (20–POAT), where POAT denotes the age at which remaining life expectancy falls below 15 years.

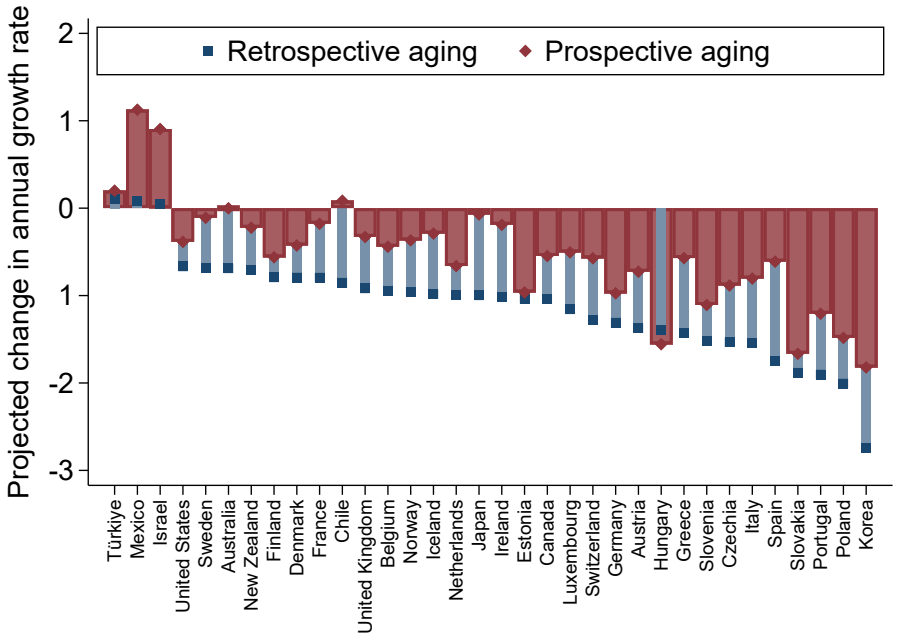
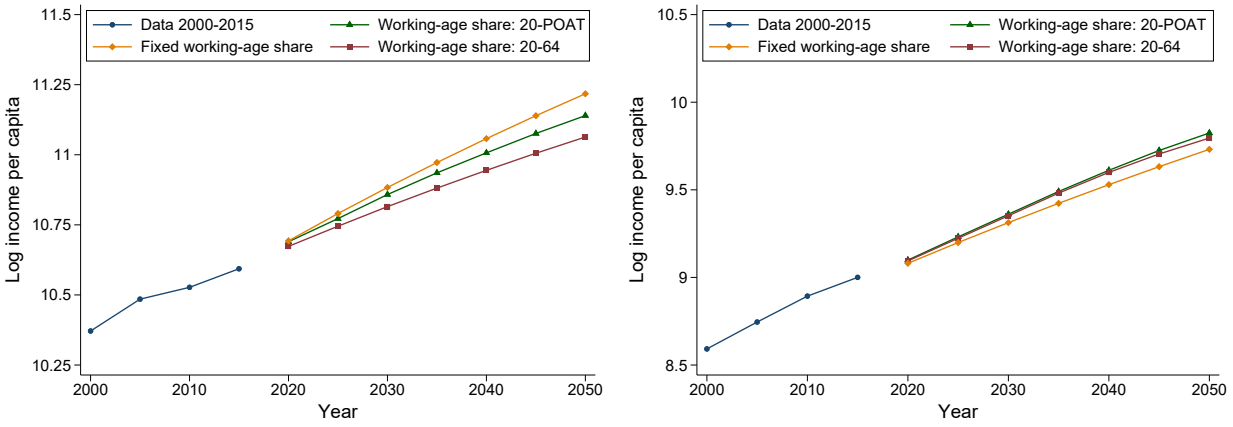


Figure B.8: Projected change in annual growth rates: Extended model

Note: This figure depicts the projected cumulative change in annual growth rates in 2020–2050 in OECD countries. It contrasts the estimated demographic drags and dividends based on the retrospective-aging scenario with the estimated demographic drags and dividends based on the prospective-aging scenario. The projections are predicated on the parameters estimated in specification (2) of Table 2.

B.6 Calibration of Key Model Parameters

The projections in our main analysis rely on parameters that are estimated with panel data. A potential concern is that the estimates might respond sensitively to changes in the covariates. To rule out the possibility that our measures of population age structure merely absorb the effects of other covariates, we project income per capita with a projection model in which we calibrate the growth and level effects of shifts in population age structure to unity and λ as our conceptual framework implies. The projections in Figures B.9 and B.10 confirm our main findings.



(a) OECD countries: 2020–2050

(b) Non-OECD countries: 2020–2050

Figure B.9: Projected income per capita: Calibrated parameters

Note: This figure shows projected income per capita for OECD and non-OECD countries in 2020–2050. The projections are based on the parameters estimated in specification (1) of Table A.8, where we calibrate the growth and level effects of the working-age share to unity and λ in accordance with the parameter constraints of our conceptual model. The figure contrasts income per capita across three projections predicated on fixed working-age shares (as of 1995 for the within-sample projections in panels a and b and as of 2015 for the out-of-sample projections in panels c and d), retrospective working-age shares (20–64), and prospective working-age shares (20–POAT), where POAT denotes the age at which remaining life expectancy falls below 15 years.

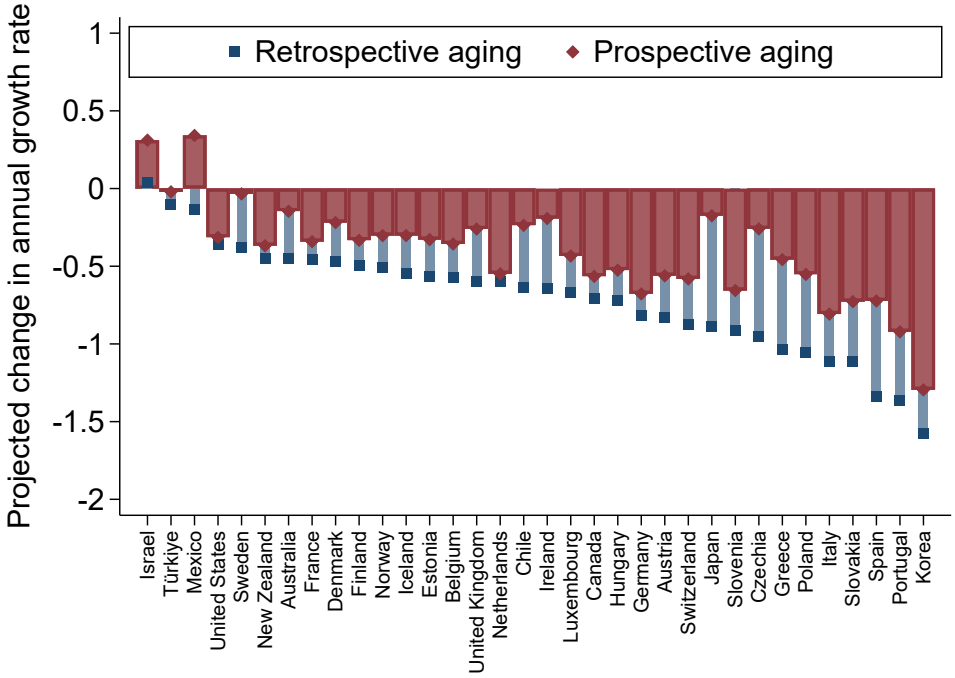
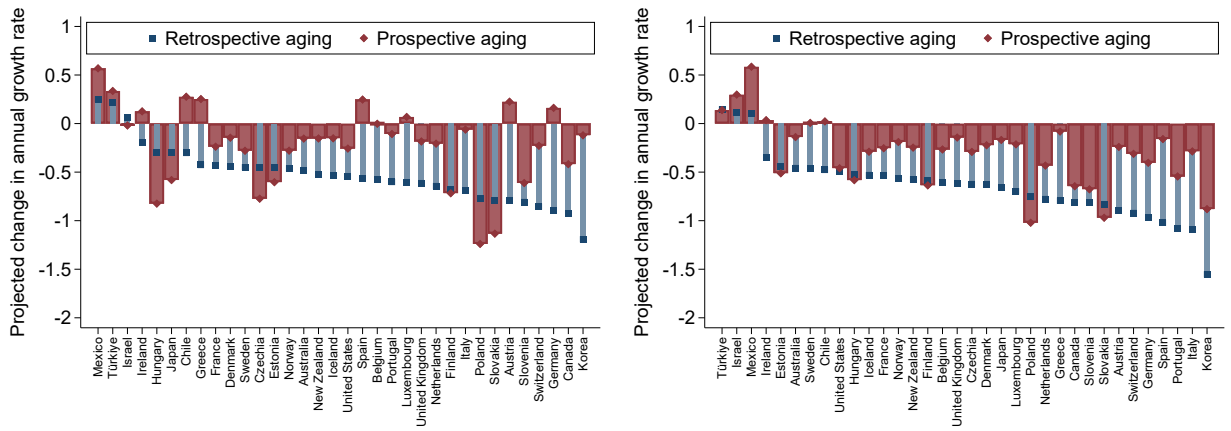


Figure B.10: Projected change in annual growth rates: Calibrated parameters

Note: This figure depicts the projected cumulative change in annual growth rates for OECD countries in 2020–2050. It contrasts the estimated demographic drags and dividends based on the retrospective-aging scenario with the estimated demographic drags and dividends based on the prospective-aging scenario. The projections are predicated on the parameters estimated in specification (1) of Table A.8, where we calibrate the growth and level effects of the working-age share to unity and λ in accordance with the parameter constraints of our conceptual model.

B.7 Shorter Time Horizons

The long time horizon of our projections raises the question of how the results of our projection analysis depend on the timing of shifts in population age structure. To address this question, we separately compute the projected change in annual growth rates of income per capita in OECD countries in 2020–2030 and in 2020–2040. Figure B.11 shows that the projected economic consequences of population aging broadly resemble the main results and support the prediction of a future demographic drag. While predictions for the cumulative effects of shifts in population age structure on annual growth rates change somewhat between periods, these changes are consistent with the timing of large cohorts entering old age. Quantitative differences between the projections under retrospective and prospective aging further indicate significant economic gains of changes in labor potential associated with improvements in people's functional capacities. By relying on shorter time horizons, this analysis also alleviates concerns about extrapolating technological growth trends from the past into the future.



(a) 2020–2030 (b) 2020–2040

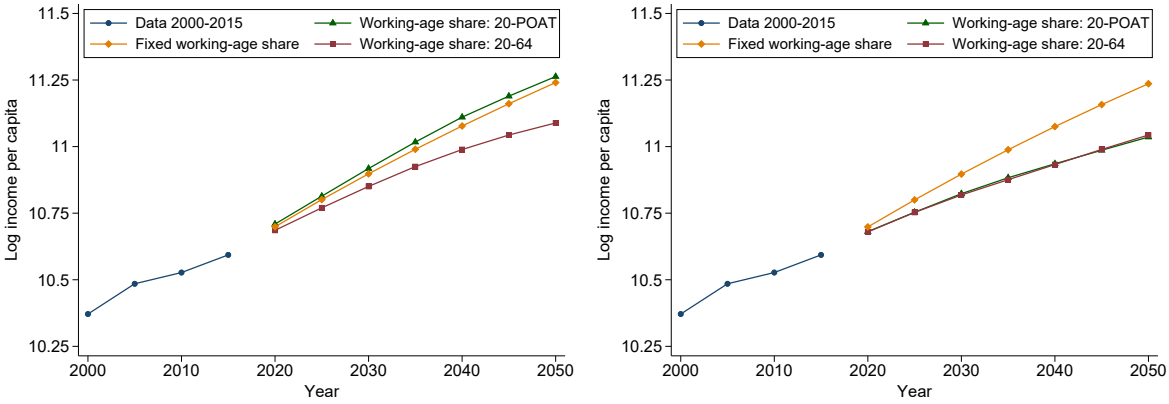
Figure B.11: Projected change in annual growth rates: 2020–2030 and 2020–2040

Note: This figure depicts the projected cumulative change in annual growth rates in OECD countries in 2020–2030 and in 2020–2040. It contrasts the estimated demographic drags and dividends based on the retrospective-aging scenario with the estimated demographic drags and dividends based on the prospective-aging scenario. The projections are predicated on the parameters estimated in specification (1) of Table 2.

B.8 Alternative Development Paths

The projection analysis uses observed and projected data on population age structure and educational attainment from the Wittgenstein Centre for Demography and Global Human Capital and on life expectancy at birth from the United Nations' World Population Prospects, relying on the variables' median scenarios. These data account for the potential interplay between population aging and human capital by modeling country-specific trends in educational attainment and life expectancy and adjusting for changes in population age structure (see Lutz et al. 2018; United Nations 2022a, for details). To gauge the extent to which uncertainty about the projected data might influence our projection results, we conducted additional analyses using two alternative development paths: one assuming rapid technological advancement, low population growth, and fast increases in educational attainment ("fast socioeconomic development") and another assuming slow technological advancement, high population growth, and slow increases in educational attainment ("slow socioeconomic development").

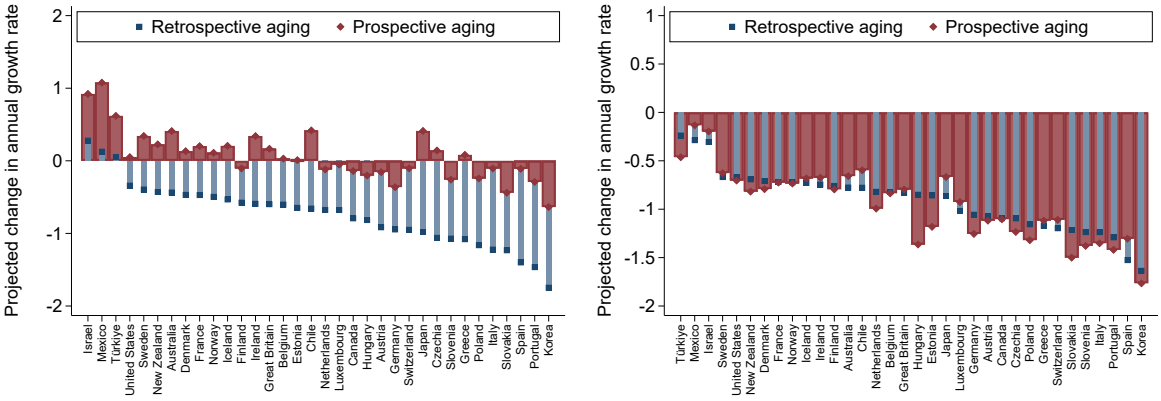
The results in Figures B.12 and B.13 show broadly similar patterns for the retrospective-aging scenarios as our main analysis, with slightly faster economic growth under fast socioeconomic development and slightly slower growth under slow socioeconomic development. The prospective-aging scenarios characterize limits for the economic effects of population aging: improvements in functional capacity can fully counteract the demographic drag under fast socioeconomic development, whereas they cannot counteract the demographic drag under slow socioeconomic development at all. Our main results lie in the middle of this range, with the no-aging and retrospective-aging scenarios under the alternative development paths as hypothetical best and worst cases.



(a) Fast socioeconomic development (b) Slow socioeconomic development

Figure B.12: Projected income per capita: Alternative development paths

Note: This figure shows projected income per capita for OECD countries in 2020–2050 under alternative development paths. The projections are based on the parameters estimated in specification (1) of Table 2. Panel (a) shows results for fast socioeconomic growth assuming rapid technological advancement, low population growth, and fast increases in educational attainment. Panel (b) shows results for slow socioeconomic growth assuming slow technological advancement, high population growth, and slow increases in educational attainment. The figure contrasts income per capita across three projections predicated on fixed working-age shares (as of 2015), retrospective working-age shares (20–64), and prospective working-age shares (20–POAT), where POAT denotes the age at which remaining life expectancy falls below 15 years.



(a) Fast socioeconomic development (b) Slow socioeconomic development

Figure B.13: Projected change in annual growth rates: Alternative development paths

Note: This figure depicts the projected cumulative change in annual growth rates for OECD countries in 2020–2050 under alternative development paths. Panel (a) assumes rapid technological advancement, low population growth, and fast increases in educational attainment. Panel (b) assumes slow technological advancement, high population growth, and slow increases in educational attainment. Both panels contrast estimated demographic drags and dividends under both retrospective-aging and prospective-aging scenarios. The projections are predicated on the parameters estimated in specification (1) of Table 2.

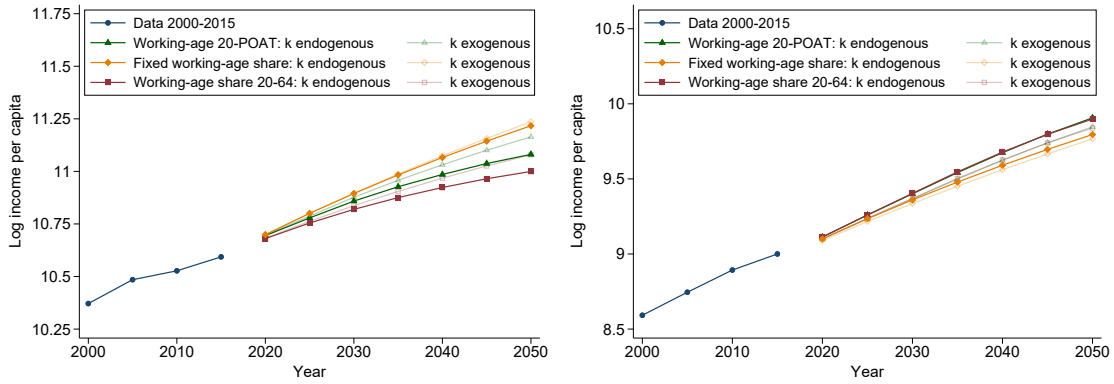
B.9 Endogenous Capital Formation

The main analysis abstracts from possible effects of population age structure on capital formation. Specifically, the projections extrapolate capital stocks with the average accumulation rate observed in the sample. This assumption reflects an extreme case in which all countries have access to a competitive international capital market in which investment cost and return equalize. On the other extreme, capital accumulation may solely depend on domestic savings, which contract when a significant proportion of the population starts dissaving for retirement. We consider the latter case by computing projections in which we endogenously determine capital formation. To this end, we regress growth of capital per worker on all other explanatory variables of our empirical model:

$$\Delta k_{it} = \lambda^k \left[\tau_t^k + \gamma^k \ln h_{it-1} + x'_{it} \delta^k - \ln \tilde{y}_{it-1} + \ln w_{it-1} \right] + \beta^k \Delta \ln h_{it} + \Delta \ln w_{it} + \varepsilon_{it}^k. \tag{B.1}$$

The superscript k highlights that parameters and residuals need not be identical to those obtained for our income regression. We use the results to iteratively update physical capital stocks and per capita incomes throughout 2020–2050.

Figures B.14 and B.15 show that projections allowing for endogenous capital formation broadly confirm the main findings. If anything, endogenizing capital formation augments the economic response to population aging: income per capita grows more when working-age shares expand and less when working-age shares contract. Improvements in functional capacity can counteract about one-third of the demographic drag in OECD countries.



(a) OECD countries (b) Non-OECD countries

Figure B.14: Projected income per capita: Endogenous capital formation

Note: This figure shows projected income per capita for OECD and non-OECD countries in 2020–2050. The projections are based on the parameters estimated in specification (1) of Table 2. We endogenously determine capital growth and iteratively update physical capital stocks and per capita incomes. The figure contrasts income per capita across three projections predicated on fixed working-age shares (as of 2015), retrospective working-age shares (20–64), and prospective working-age shares (20–POAT), where POAT denotes the age at which remaining life expectancy falls below 15 years. Shaded lines display projected income per capita under exogenous capital formation.

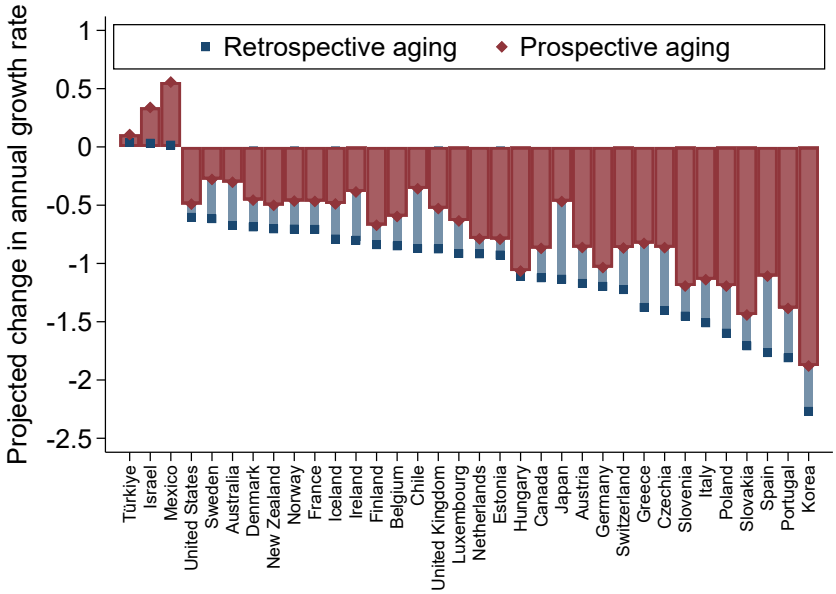
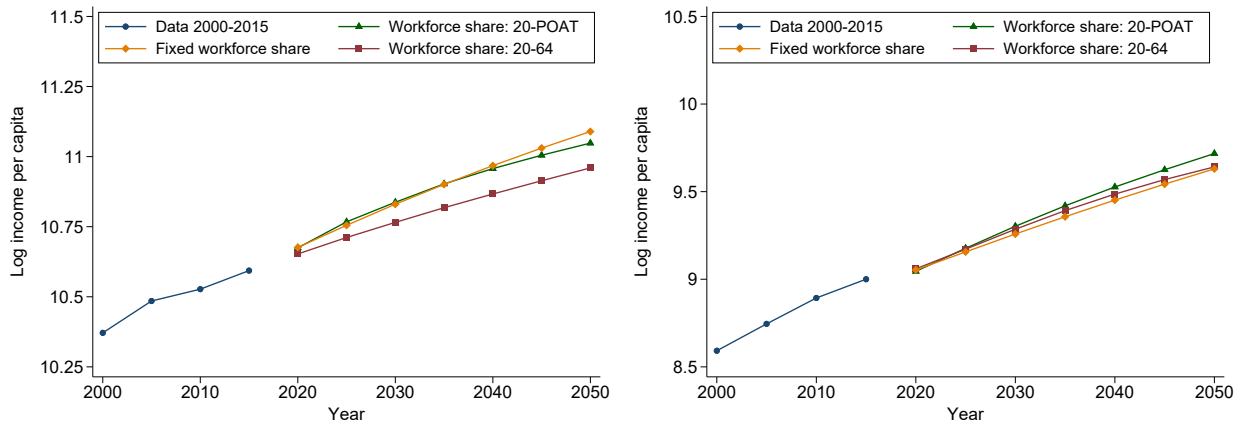


Figure B.15: Projected change in annual growth rates: Endogenous capital formation

Note: This figure depicts the projected cumulative change in annual growth rates in 2020–2050 in OECD countries. It contrasts estimated demographic drags and dividends under retrospective-aging and prospective-aging scenarios. The projections are predicated on the parameters estimated in specification (1) of Table 2. We endogenously determine capital growth and iteratively update physical capital stocks and per capita incomes.

B.10 Projections Based on Workforce Shares

The projections in our main analysis predict economic growth based on working-age rather than workforce shares because projections of labor force participation are fraught with uncertainty—especially since the Covid-19 pandemic's unprecedented shock to labor markets (International Labour Organization 2021). Nevertheless, gauging the results' sensitivity to workforce measures is possible if one is willing to make assumptions about labor force participation in the years ahead. One option is to assume that increasing participation among older workers balances decreasing overall participation caused by compositional shifts from prime-age to older workers, such that average labor force participation in the population remains constant. The corresponding results in Figures B.16 and B.17 show similar trends in income per capita as the main analysis. Increases in prospective old-age thresholds can cushion about 60 percent of the demographic drag in OECD countries. This portion increases with labor force participation, suggesting appreciable economic gains for policies that promote employment opportunities for older workers.



(a) OECD countries

(b) Non-OECD countries

Figure B.16: Projected income per capita: Workforce estimates

Note: This figure shows projected income per capita for OECD and non-OECD countries in 2020–2050. The projections are based on the parameters estimated in specification (1) of Table A.15. The figure contrasts income per capita across three projections predicated on fixed working-age shares (as of 2015), retrospective working-age shares (15–64), and prospective working-age shares (15–POAT), where POAT denotes the age at which remaining life expectancy falls below 15 years. Workforce shares are derived by multiplying the working-age population by the average labor force participation among people age 15 and older.

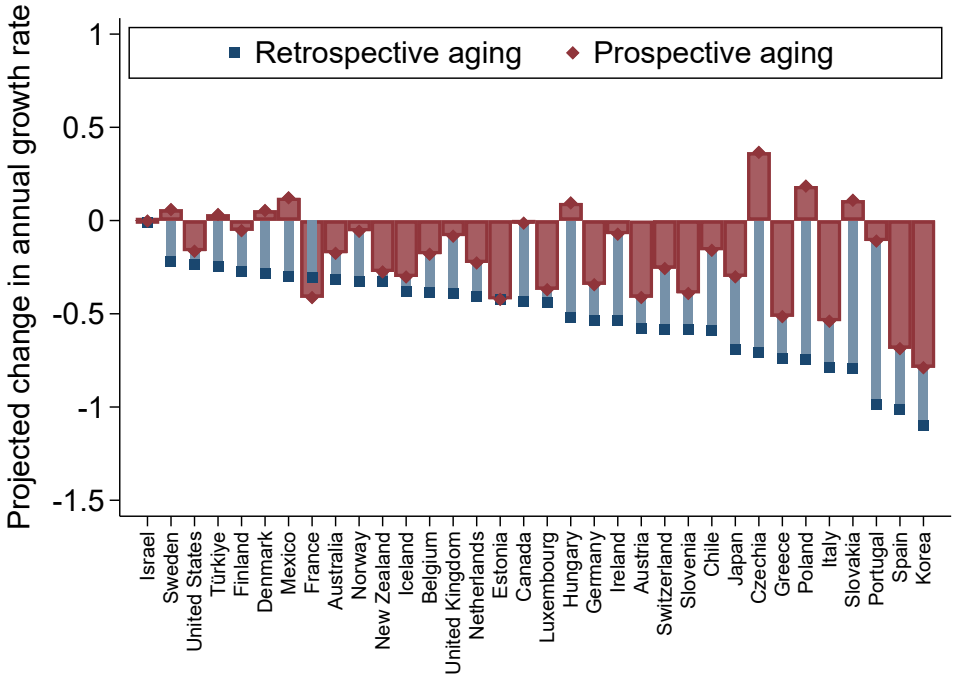


Figure B.17: Projected change in annual growth rates: Workforce estimates

Note: This figure depicts the projected cumulative change in annual growth rates in 2020–2050 in OECD countries. It contrasts estimated demographic drags and dividends under retrospective-aging and prospective-aging scenarios. The projections are predicated on the parameters estimated in specification (1) of Table A.15. Workforce shares are derived by multiplying the working-age population by the average labor force participation among people age 15 and older.

C Functional Capacity and Economic Activity at Older Ages

An open question is whether people remain economically active at older ages when their functional capacities increase. To assess whether this is the case, we use aggregated data on people's intention to work at older ages and their observed labor force participation obtained from the Health and Retirement Survey (HRS 2022) and the Survey of Health, Ageing and Retirement in Europe (Börsch-Supan 2022). We regress the propensity to work full time beyond age 62 (measured by the share of people aged 50–62 who state a positive probability to work full time beyond age 62) and labor force participation in the age group 63–75 on the prospective old-age threshold: see Table C.1. While the propensity to work full time at older ages tends to increase with functional capacity—a one-year rise in the prospective old-age threshold is associated with a 15 percentage point higher propensity to work full time beyond 62—observed labor force participation does not increase with functional capacity. These findings suggest that other factors, such as labor market conditions for older workers and the institutional environment, limit the extent to which economic activity extends into older ages as functional capacity improves.

Table C.1: Prospective old-age threshold and economic activity at older ages

Dependent variable:	Propensity to work full time beyond age 62 (1)	Labor force participation in age group 63–75 (2)
Prospective old-age threshold (coefficients × 100)	15.23* (8.17)	−0.77 (2.09)
R^2	0.77	0.95
Within R^2	0.04	0.00
Countries	21	22
Observations	73	79

Note: This table shows correlations between the prospective old-age threshold (defined as the age at which remaining life expectancy falls below 15 years) and the propensity to work full time beyond age 62 (1) and between the prospective old-age threshold and labor force participation in age group 63–75 (2). Propensity to work full time beyond age 62 measures the share of people aged 50–62 who state a positive probability of working full time beyond age 62 (beyond age 61 in the United States). All regressions include country fixed and time effects. Standard errors are clustered at the country level and reported in parentheses. Asterisks indicate significance levels: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

D Data Acknowledgment

This study uses data from Waves 1–9 of the English Longitudinal Study of Ageing, which was developed by a team of researchers based at University College London, NatCen Social Research, the Institute for Fiscal Studies, the University of Manchester, and the University of East Anglia. The data were collected by NatCen Social Research. The funding is currently provided by the National Institute on Aging in the United States and by a consortium of United Kingdom government departments coordinated by the National Institute for Health Research. Funding has also been received from the Economic and Social Research Council.

The study also uses data from Waves 1–14 of the U.S. Health and Retirement Survey (HRS), which were retrieved from the RAND HRS Longitudinal File. The RAND HRS Longitudinal File is an easy-to-use dataset based on the HRS core data. This file was developed at RAND with funding from the U.S. National Institute on Aging and the United States Social Security Administration. The HRS is sponsored by the U.S. National Institute on Aging (grant number NIA U01AG009740) and is conducted by the University of Michigan.

Finally, this study uses data from Waves 1–8 of the Survey of Health, Ageing and Retirement in Europe (SHARE). The SHARE data collection has been funded by the European Commission, DG RTD through FP5 (QLK6-CT-2001-00360), FP6 (SHARE-I3: RII-CT-2006-062193, COMPARE: CIT5-CT-2005-028857, SHARELIFE: CIT4-CT-2006-028812), FP7 (SHARE-PREP: GA N°211909, SHARE-LEAP: GA N°227822, SHARE M4: GA N°261982, DASISH: GA N°283646), and Horizon 2020 (SHARE-DEV3: GA N°676536, SHARE-COHESION: GA N°870628, SERISS: GA N°654221, SSHOC: GA N°823782, SHARE-COVID19: GA N°101015924), and by DG Employment, Social Affairs & Inclusion through VS 2015/0195, VS 2016/0135, VS 2018/0285, VS 2019/0332, and VS 2020/0313. Additional funding from the German Ministry of Education and Research, the Max Planck Society for the Advancement of Science, the U.S. National Institute on Aging (U01_AG09740-13S2, P01_AG005842, P01_AG08291, P30_AG12815, R21_AG025169, Y1-AG-4553-01, IAG_BSR06-11, OGHA_04-064, HHSN271201300071C, RAG052527A), and from various national funding sources is gratefully acknowledged (see www.share-project.org). SHARE data were harmonized using information from the Gateway to Global Aging Data produced by the Program on Global Aging, Health & Policy, University of Southern California with funding from the U.S. National Institute on Aging (R01 AG030153).