Population Aging and Economic Growth: a Framework for Cross-Country Analysis

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Abstract

Population aging is reshaping economic growth prospects across countries by altering both the size and age composition of the workforce. This paper integrates evidence from literature on demographics and economic growth into a unified and transparent framework to provide a practical approach for assessing and comparing the growth implications of aging across countries. Building on a standard growth-accounting approach derived from the Solow–Swan model, the framework decomposes aging-related effects into three channels: changes in the size of the working-age population, changes in total factor productivity associated with an aging workforce, and capital deepening arising from a higher capital–labor ratio. The paper operationalizes the framework using data from the Penn World Table and the United Nations World Population Prospects to generate country-specific projections. The estimates are intended to provide a stylized assessment of the direction and approximate magnitude of aging-related growth effects across countries rather than precise forecasts.

Motivation and purpose

Population aging is one of the most consequential demographic transformations of the twenty-first century. Nearly all countries are projected to experience a rising share of older individuals in their populations over the coming decades (Bloom & Luca, 2016). While population aging represents a developmental success, reflecting gains in life expectancy and improvements in family planning, the accompanying shift in population age structures also presents multisectoral challenges for healthcare, pension, and long-term care systems, individual well-being, fiscal sustainability, and economic growth.

This paper presents a framework for assessing how population aging may affect economic growth. Drawing on the economic literature, it focuses on two channels through which aging negatively influences growth outcomes across countries. First, aging reduces the size of the workforce relative to the total population, altering the economy's labor supply. Second, it increases the age composition of the labor force which may influence total factor productivity (TFP). In addition, the framework provides calculations of how much capital deepening could offset the adverse effects associated with a shrinking workforce. Other potential channels, such as changes in savings behavior, are

excluded because empirical evidence suggests that their contribution to the growth effects of population aging is limited and highly context-dependent (Lee & Shin, 2021; Maestas et al., 2016).

The effect of population aging on economic growth through changes in the relative size of the workforce is one of the most well-established findings in the demographic and growth literature (Amaglobeli & Shi, 2016; Bloom & Williamson, 1998). As fertility declines and life expectancy increases, the share of the population in age groups with high labor force participation tends to fall relative to the total population. This deterioration in what is called the support ratio reduces the number of workers available to sustain economic activity. In the absence of offsetting adjustments in labor market behavior, the resulting decline in effective labor supply mechanically lowers output per capita and slows economic growth.

Population aging also reshapes the age distribution within the workforce. While the productivity of individual workers does not appear to decline systematically with age, the literature has consistently finds that changes in the age structure of the workforce may affect total factor productivity (TFP) by slowing the processes that drive technological progress, particularly innovation and entrepreneurship (Aiyar et al., 2016; Feyrer, 2007; Maestas et al., 2023; Radelet et al., 1997). As these activities are central to productivity growth, a less dynamic economic environment may reduce aggregate productivity even in the absence of a decline in the productivity of individual workers (Börsch-Supan & Weiss, 2023).

Our framework also incorporates capital deepening as a potential mitigating mechanism. As population aging reduces the size of the workforce, and holding savings behavior constant, the capital–labor ratio would tend to increase. This rise in capital intensity can boost output per worker, partially offsetting the negative impact of a shrinking labor force on output per capita (Lee & Mason, 2010). While the mechanism is theoretically straightforward, empirical evidence suggests that capital deepening has played a limited role in offsetting the negative effects of population aging on economic growth (Lee & Shin, 2021). To remain conservative, the framework allows for capital deepening to mitigate part of the adverse impact of aging. As a result, the calculated effects presented in this paper should be interpreted as a lower-bound assessment in this regard.

Throughout this paper, we treat the first channel; the impact operating through the relative size of the workforce, as the baseline, and consider the productivity channel as a pessimistic scenario in which population aging also reduces TFP growth. Demographic dynamics are relatively predictable over medium- to long-term horizons, as workforce size is largely determined by past fertility trends embedded in the population's age structure, rendering changes in the working-age population effectively predetermined (Lee, 2011). As a result, the labor supply channel is relatively certain, mechanical, and well identified. By contrast, the impact of aging on productivity remains more uncertain, with mixed empirical evidence, and is therefore treated as a downside scenario rather than part of the baseline (Acemoglu & Restrepo, 2017; Börsch-Supan & Weiss, 2023).

This framework is intended to provide a stylized assessment of the direction and potential magnitude of the impact of population aging on economic growth, rather than a precise econometric forecast. It isolates a set of demographic and macroeconomic channels and applies them in a stylized growth-accounting framework. While this makes the results easy to interpret and compare across countries, the estimates should be interpreted as a benchmark for assessing the

potential direction and magnitude of aging-related growth effects, rather than as precise predictions of future economic outcomes. They are subject to important limitations, including the abstraction from behavioral and policy responses, the reliance on a simple production structure with constant factor shares, the reduced-form treatment of productivity effects, and the omission of sectoral and regional heterogeneity.

This paper contributes to the literature in three ways. First, it integrates multiple channels through which population aging may affect economic growth within a unified growth-accounting framework. Second, it translates findings from a large empirical literature into a stylized and operational methodology that can be applied consistently across countries using publicly available datasets. Third, the framework generates a comparable country-specific assessment of aging impacts on growth under a common set of assumptions, providing a benchmarking tool that can support cross-country analysis and policy discussions.

The following sections present the analytical framework, describe the methodology used to quantify the impact of population aging on economic growth, discuss the underlying data requirements and projection assumptions, and illustrate the outputs generated by the framework, together with guidance on their interpretation in light of the model's limitations.

Analytical framework

This framework quantifies the contribution of demographics to growth in GDP per capita across countries and over time. The approach Is based on growth accounting. The analytical foundation is the Solow–Swan growth model expressed through a Cobb-Douglass function, which separates GDP growth into the contributions from capital (K^{α}) and labor ($L^{1-\alpha}$), and total factor productivity (A) (Jones & Vollrath, 2024; Solow, 1956).

$$Y = AK^{\alpha}L^{1-\alpha} \qquad \text{(eq 1.)}$$

We apply a series of transformations to Equation 1 in order to isolate demographic effects on growth:

- Divide by total population (N) to obtain GDP per capita;
- Multiply and divide by the working-age population on the right-hand side (W) to introduce the support ratio explicitly;
- Apply a log-linear growth decomposition to express contributions in growth-rate terms.

$$g_{Y/N} = gA + \alpha g_{K/L} + g_{W/N} + g_{L/W} \qquad \text{(eq. 2)}$$

Where g_x denote the log-growth rate of any variable x.

The contribution from productivity (gA) can be decomposed to separate the effects of demographics on productivity growth ($gAdem$) from all other factors affecting productivity growth ($gAother$).

Specifically:

$$gA = gAdem + gAother \qquad \text{(eq. 3)}$$

Introducing eq. 3 and reordering terms we obtain

$$g_{Y/N} = g_{W/N} + g_{L/W} + \alpha g_{K/L} + gAdem + gAother \quad \text{(eq. 4)}$$

Equation 4 decomposes growth in GDP per capita into the following elements:

- $g_{W/N}$, which captures the impact of aging through changes in the relative size of the working age population.
- $g_{L/W}$, which captures changes in labor participation and or employment.
- $\alpha g_{K/L}$, which captures capital deepening, i.e., changes in the ratio of capital per worker.
- $gAdem$, which captures changes in growth in productivity due to changes in demographics.
- $gAother$, which captures changes in growth in productivity unrelated to demographics.

Our computations for the impact on growth are done by comparing a scenario where population aging takes place ($g^{A}_{Y/N}$) with a theoretical scenario where the age-composition of the population remains constant across time, i.e., population aging does not take place ($g^{NA}_{Y/N}$). Specifically, the effect of aging on growth per capita is measured as:

$$\Delta g_{Y/N} = g^{NA}_{Y/N} - g^{A}_{Y/N} \quad \text{(eq. 5)}$$

We are interested in measuring the contribution of those factors directly affected by demographics: $g_{W/N}$, $gAdem$, $\alpha g_{K/L}$. The share of TFP explained by factors other than demographics ($gAother$) and the growth rate of capital (K) are assumed to be the same under both scenarios.[1]

Extending equation 5 to the three factors affected by demographics, we obtain:

Contribution through the relative size of the workforce

$$\Delta g_{W/N} = g^{NA}_{W/N} - g^{A}_{W/N} = -g^{A}_{W/N} \quad \text{(eq. 6)}$$

Contribution through productivity

$$\Delta gAdem = gAdem^{NA} - gAdem^{A} = -gAdem^{A} \quad \text{(eq. 7)}$$

Contribution through capital deepening[2]

$$\Delta(\alpha g_{K/L}) = \alpha(g^{NA}_{K/L} - g^{A}_{K/L}) = \alpha({g_{W/N}}^{A}) \quad \text{(eq. 8)}$$

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[1] While capital accumulation is in principle endogenous to demographics, since demographic shifts affect growth, saving behavior, and thus the evolution of the capital stock, this paper assumes the same growth rate of K across the baseline and counterfactual scenarios. This is a conservative assumption: if adverse demographics also depress capital formation, the true impact of demographic change on capital deepening and output growth would be larger than the estimates reported here. Hence, the estimates presented here should be treated as conservative in this regard.

[2] See detailed steps described in Annex 1.

Data and computation assumptions

Penn World Table (PWT) data are used to construct all variables for the historical period, with the exception of the decomposition of gA (Feenstra et al., 2015). The PWT series ends in 2019. Beyond this point, population variables are projected forward by indexing them to the United Nations World Population Prospects projections (UN, 2024).

Over the projection horizon, the labor force (L) is assumed to remain constant as a share of the working-age population (W), implying no projected changes in labor force participation or employment rates. K is assumed to grow at the same rates under both, aging and non-aging scenarios. This is a conservative assumption, capital would likely grow slower in an aging scenario, reducing the positive effect of capital deepening on growth in a population aging context.

The impact of aging on growth through productivity ($gDem$) is derived from the empirical estimates of Guénette and Shao (2025), who quantify how changes in the age structure of the working-age population influence economic growth. Their analysis, building on the approach of Feyrer (2007), shows that productivity varies systematically by age group, with middle-aged workers (40–49) contributing the most to total factor productivity. Using cross-country and time-series data, they estimate how shifts in the shares of each age group affect trend productivity growth.

The coefficients estimated by Guénette & Shao (2025) capture the marginal productivity contribution of each cohort. We use their results to compute $gDem$ by weighting projected changes in the age distribution (based on UN population data) with the age-specific productivity elasticities identified in the paper.

Results

The framework can be applied consistently across a broad set of countries. Results are currently available for 161 countries, allowing for systematic cross-country comparisons of the potential growth implications of population aging under a common set of assumptions.

Table 1 illustrates the results for a selected group of countries at different stages of the demographic transition. The table reports the average annual contribution of demographic factors to GDP per capita growth between 2025 and 2055. The baseline scenario includes the effects of changes in the relative size of the workforce and the associated capital-deepening offset, while the pessimistic scenario additionally assumes that workforce aging reduces total factor productivity growth. A value of -0.5, for example, indicates that demographic change reduces average annual GDP per capita growth by 0.5 percentage points over the period considered.

Table 1. Average annual contribution of demographic factors to GDP per capita growth, percentage points, 2025–2055.

Country	Impact through workforce size	Capital offset	Impact through TFP	Baseline (excluding impact on TFP)	Pessimistic (including impact on TFP)
Korea, Rep.	-1.03	0.50	-0.57	-0.53	-1.10
China	-0.71	0.30	-0.41	-0.42	-0.83
Thailand	-0.60	0.22	-0.37	-0.39	-0.75
Italy	-0.63	0.30	-0.39	-0.33	-0.72

Costa Rica	-0.47	0.20	-0.20	-0.27	-0.47
Japan	-0.45	0.20	-0.27	-0.25	-0.52
Brazil	-0.40	0.17	-0.20	-0.23	-0.43
Tunisia	-0.29	0.14	-0.15	-0.14	-0.29
United States	-0.22	0.09	-0.12	-0.13	-0.25
India	-0.09	0.04	0.04	-0.05	-0.01
South Africa	-0.06	0.02	0.01	-0.03	-0.02

Source: Author's calculations.

Three broad patterns emerge. First, the largest estimated demographic drags are concentrated in countries experiencing rapid aging transitions. Korea faces the largest effect in the sample presented here, with aging reducing GDP per capita growth by 0.53 percentage points annually under the baseline scenario and by 1.10 percentage points when productivity effects are included. China and Thailand also experience sizable effects, despite having younger populations than Japan. This highlights that the pace of demographic change, rather than the level of aging itself, is a key determinant of the growth effects captured by the framework.

Second, capital deepening only partially offsets demographic headwinds. Across countries, the increase in the capital–labor ratio compensates for roughly one-third of the negative effect associated with a declining support ratio, leaving a substantial net drag on growth. This offset is likely conservative, as the framework assumes that capital accumulation is unaffected by demographic change.

Third, assumptions regarding productivity matter considerably. Incorporating the possibility that workforce aging lowers TFP growth approximately doubles the estimated impact in several countries, suggesting that uncertainty surrounding the productivity channel remains one of the most important sources of variation in long-run assessments of aging-related growth effects.

These estimates should not be interpreted as forecasts of future GDP per capita growth. Instead, they isolate the contribution of demographic change to growth under a common set of assumptions, providing a benchmark against which countries can evaluate the potential importance of population aging. Actual growth outcomes may differ substantially, as individuals, firms, and governments adjust to demographic change through higher labor force participation, migration, technological adoption, capital accumulation, and policy reforms. The estimates are therefore best understood as an assessment of the direction and approximate magnitude of demographic pressures on growth, rather than as predictions of future economic performance.

Limitations

This tool should be viewed as a first-order benchmark to the potential impacts of population aging on economic growth. It is best suited to indicate the likely direction and approximate magnitude of the impact of aging on growth, and to compare the relative importance of different channels across countries, rather than to provide precise point estimates. It isolates a small set of demographic and macroeconomic channels and applies them in a stylized, growth-accounting framework. While this makes the results easy to interpret and compare across countries, it also implies important limitations that should be borne in mind when interpreting the estimates.

First, the framework is based on a structural, model-driven decomposition rather than an econometric estimation strategy. It imposes a specific production structure and demographic channels and uses data to quantify them, rather than statistically identifying the causal effect of aging on growth from historical variation. As a result, the estimates are sensitive to the modeling assumptions and should be interpreted as scenario-based projections, not as econometrically identified causal effects.

Second, the also framework abstracts from behavioral responses on the labor side, especially labor-force participation, which may increase in response to aging and thereby mitigate some of the negative effects on growth. This is intentional, as the objective is to isolate the mechanical impact of demographic change under current participation patterns and to provide a transparent benchmark. In practice, policy reforms and individual responses could raise participation among older workers and women, thereby attenuating the growth effects reported here.

Third, the model relies on a simple Cobb–Douglas production function with constant factor shares, which may not capture changes in technology, sectoral structure, or the elasticity of substitution between capital and labor. Additionally, the analysis is conducted at an aggregate level and does not capture differences across sectors, regions, or types of workers, nor does it model policy responses (for example, pension or labor-market reforms) that may themselves be triggered by aging.

Discussion

This paper presents a framework for assessing how population aging may affect economic growth. It brings together evidence from different strands of the literature into a unified growth-accounting framework that captures three channels through which aging may influence GDP per capita growth: changes in the relative size of the workforce, changes in total factor productivity associated with workforce aging, and capital deepening. While the first two channels reflect mechanisms for which the empirical literature identifies a direct relationship between aging and growth, capital deepening is incorporated as a mitigating force that partially offsets the adverse effects of a shrinking workforce.

Using data from the Penn World Table and the United Nations World Population Prospects, we operationalize the framework and generate comparable estimates for 161 countries under a common set of assumptions. The results highlight considerable variation in the potential growth implications of demographic change across countries over the next decades. In particular, countries undergoing the most rapid demographic transitions tend to face the largest projected drags on GDP per capita growth, reflecting the importance of the pace of aging, rather than the level of aging itself, in shaping growth outcomes. The estimates also indicate that capital deepening offsets only part of the growth drag associated with declining support ratios, while the productivity channel remains an important source of uncertainty in assessing the long-run economic consequences of population aging.

These estimates should not be interpreted as forecasts of future GDP per capita growth. Rather, they provide a stylized and comparable benchmark that isolates the contribution of demographic change to economic growth under a common set of assumptions. As such, they are best viewed as an assessment of the direction and approximate magnitude of

demographic pressures on growth, against which the potential role of behavioral responses, technological change, migration, and policy interventions can be evaluated.

Annex. The effect of capital deepening under exogenous and endogenous assumptions for capital formation

This annex shows that relaxing the assumption of exogenous capital accumulation (allowing saving and investment to respond to slower growth) reduces the buffering effect of capital deepening; thus, the baseline results in the main text should be interpreted as conservative in this regard.

We start with a decomposition of GDP per capita growth shown in equation 2.

$g_{Y/N} = gA + \alpha g_{K/L} + g_{W/N} + g_{L/W}$

The effect of aging is measured by comparing growth in GDP per capita ($g_{Y/N}$) in a scenario without aging vs a scenario with aging.

1) **Scenario 1 Aging (A)**: The working-age share declines, so ${g_{W/N}}^{A} < 0$.
2) **Scenario 2 No Aging (NA)**: The working-age share is constant, so ${g_{W/N}}^{NA} = 0$.

Common assumptions across scenarios

- Employment and labor participation rates are constant across scenarios:
  ${g_{L/W}}^{A} = {g_{L/W}}^{NA} = 0$; this assumption entails g_L=g_W

- Population grows at the same rate in both scenarios:
  ${g_N}^{A} = {g_N}^{NA} = g_N$

- To simplify the comparison, we also assume that TFP growth (gA) is identical in both scenarios.

Comparing non-aging to aging with the same growth rate for K

Capital growth is exogenous and the same in both scenarios: ${g_K}^{A} = {g_K}^{NA}$.

Capital deepening:

Capital deepening with No Aging minus capital with Aging:

$\alpha \Delta g_{K/L} = \alpha({g_{K/L}}^{NA} - {g_{K/L}}^{A}) = \alpha({g_K}^{NA} - {g_K}^{A}) - \alpha({g_L}^{NA} - {g_L}^{A})$

Because ${g_K}^{A} = {g_K}^{NA}$, we get

$\Delta g_{K/L} = \alpha(-g_L{}^{NA} + g_L{}^{A})$

As g_L=g_W, we can transform this equation into

$\Delta g_{K/L} = -g_L{}^{NA} + g_L{}^{A} = -g_W{}^{NA} + g_W{}^{A} + (g_N - g_N) = -g_{W/N}{}^{NA} + g_{W/N}{}^{A} = 0 + g_{W/N}{}^{A}$

$$\boldsymbol{\alpha \Delta g_{K/L}} = \alpha \boldsymbol{g_{W/N}{}^{A}} \qquad \text{(eq. A1)}$$

GDP per capita:

$\Delta g_{Y/N} = \alpha \cdot \Delta g_{K/L} + \Delta g_{W/N}$

$-g_{W/N}{}^{NA} = 0$, thus

$$\boldsymbol{\Delta g_{Y/N}} = \boldsymbol{\alpha g_{W/N}{}^{A} - g_{W/N}{}^{A}} = \boldsymbol{(\alpha - 1) g_{W/N}{}^{A}} \qquad \text{(eq. A2)}$$

Remember that, for an aging country, $g_{W/N}{}^{A}$ is negative. Thus, the growth differential between scenarios NA and A is positive, i.e., countries grow faster in absence of aging.

When capital growth is the same under both scenarios, capital deepening partially offsets the effect of aging on growth per capita but only by a fraction determined by α. The net differential is given by $\boldsymbol{(\alpha - 1) g_{W/N}{}^{A}}$

Comparing non aging to aging with different paths for K

Now we assume that capital accumulation responds positively to growth. Since output grows faster in the no-aging scenario, capital growth is higher there: $g_K{}^{NA} > g_K{}^{NA}$.

Capital deepening:

$\alpha \Delta g_K = \alpha(g_K{}^{NA} - g_K{}^{A}) + \alpha(g_L{}^{NA} - g_L{}^{A})$

$$\boldsymbol{\alpha \Delta g_{K/L}} = \boldsymbol{\alpha(g_K{}^{NA} - g_K{}^{A}) + \alpha g_{W/N}{}^{A}} \qquad \text{(eq. A3)}$$

Compare to eq A1. The only difference is the term $\alpha(g_K{}^{NA} - g_K{}^{A})$, which can be assumed to be negative due to weaker investment when aging reduces output growth. Thus, capital deepening is smaller when *K* is allowed to respond to $g_{Y/N}$.

GDP per capita:

$\Delta g_{Y/N} = \alpha \Delta g_{K/L} + \Delta g_{W/N}$

Replacing capital deepening with eq 3 and because $g_{W/N}{}^{NA} = 0$:

$$\boldsymbol{\Delta g_{Y/N} = \alpha(g_K{}^{NA} - g_K{}^{A}) + \alpha g_{W/N}{}^{A} - g_{W/N}{}^{A}} \quad \text{(eq. 4)}$$

Compare eq A4 with eq A2. $\alpha(g_K{}^{NA} - g_K{}^{A})$ is negative, thus compared with the fixed-K case, the growth gap is larger.

Table 4. Scenario comparison

Channel	Fixed K	Endogenous K (linked to gY)
Support ratio $\Delta g_{W/N}$	Negative effect: $-g_{W/N}{}^{A}$	Same negative effect: $-g_{W/N}{}^{A}$
Capital deepening $\alpha \Delta g_{K/L}$	Positive effect mediated by $\boldsymbol{\alpha}$: $\alpha g_{W/N}{}^{A}$	Lower positive effect due to lower capital accumulation: $\alpha(g_K{}^{NA} - g_K{}^{A}) + \alpha g_{W/N}{}^{A}$

Source: Author own work.

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