

Heterogeneous demographic transitions and equilibrium real interest rates in Latin America^{*}

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Abstract

We quantify the contribution of demographic change to equilibrium real interest rates in Latin America. We develop a tractable overlapping generations model that combines population projections from 1950 to 2100 with labor efficiency profiles estimated from household surveys for seven economies at different stages of the demographic transition. Common preferences and technology allow cross country differences in equilibrium real rates to be attributed to demographic dynamics and changes in labor force composition. From their respective peaks to 2050, demographic forces lower the equilibrium real rate by approximately 0.8 to 1.6 percentage points across countries. The timing of the decline varies substantially: it begins earlier in economies undergoing rapid demographic transitions, while sustained downward pressure emerges only around 2040 in countries with more gradual transitions. This variation is primarily driven by the point at which effective labor begins to grow more slowly than the population. By holding other determinants fixed, our approach isolates a long run demographic component of equilibrium real rates rather than estimating the neutral policy rate itself.

Keywords: equilibrium real interest rate; demographic transition; population aging; overlapping generations; Latin America.

JEL classification: E43; E52; J11; H55.

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1 Introduction

Demographic change is reshaping Latin America’s long term macroeconomic environment. Falling fertility, longer lives, and slower growth of the working age population are bringing the region’s demographic dividend to an end. These changes are persistent and relatively predictable. For central banks, whether demographic changes affect the equilibrium real interest rate is of particular importance, since a policy rate that was neutral in the past may become restrictive or expansionary even without a conventional business cycle shock.

Latin America provides a useful setting in which to study this mechanism. Its demographic transition began later than in most advanced economies, is proceeding rapidly, and differs markedly across countries. This paper asks three questions. How large is the demographic contribution to equilibrium real interest rates? When does it become quantitatively relevant? What explains the differences across economies? We answer these questions using publicly available data from Argentina, Brazil, Chile, Colombia, Mexico, Peru, and Uruguay. We combine the 2024 population estimates and projections produced by the CELADE Population Division of ECLAC and the United Nations with comparable labor efficiency profiles constructed from national household surveys ([CELADE–Population Division of ECLAC and United Nations Population Division, 2024](#)). The diversity of demographic trajectories across the region is a key advantage for our analysis, as it allows us to study the same mechanism at different stages of the transition.

Life cycle models identify three main channels. Slower growth in effective labor reduces capital demand relative to the number of consumers and, under diminishing returns, lowers the marginal product of capital. Longer expected lifetimes strengthen incentives to accumulate assets and add downward pressure on the equilibrium rate. A larger retired population may partly offset these forces as households draw down wealth to finance consumption ([Carvalho et al., 2016](#)). Studies of advanced economies find that changes in age composition can materially affect saving, investment, output growth, and real interest rates. The estimated magnitude depends on labor participation, pension arrangements, and the speed of demographic change ([Aksoy et al., 2019](#); [Gagnon et al., 2021](#); [Papetti, 2021](#); [Jones, 2023](#)).

International financial integration affects the link between domestic demographics and domestic interest rates. Capital mobility reallocates saving and investment across economies, so domestic rates respond to both local and global demographic forces ([Arslanalp et al., 2018](#); [Carvalho et al., 2025](#)). This consideration is particularly relevant for emerging markets. In a model with several regions, [Attanasio et al. \(2015\)](#) show that openness changes the effects of Latin American demographics on saving, capital accumulation, and factor prices. Using historical data, [Cavallo et al. \(2018\)](#) find that demographic variables explain less of the variation in saving rates across Latin American countries than across Asian countries. These findings caution against treating domestic

demographic projections as complete forecasts of observed interest rates. They do not, however, identify the domestic general equilibrium pressure generated by each country's projected age structure. That pressure is the object isolated here.

Our analysis also complements estimates of neutral interest rates based on filters, semistructural models, and financial market information (Laubach and Williams, 2003; Holston et al., 2017; Gómez-Pineda, 2019; Juárez, 2023; Magud and Tsounta, 2012; Ortiz, 2018; Ceballos et al., 2024). Those approaches incorporate productivity, global rates, risk premia, and other latent forces. We instead hold nondemographic determinants constant and quantify one slow moving component. The model is not intended to reproduce the full historical path of neutral rate estimates in Latin America or to prescribe a short term policy rate. Instead, it identifies how domestic demographics alter the long term equilibrium around which other forces operate. The paper also complements Velín-Fárez (2025), who use an overlapping generations (OLG) model to evaluate pension reforms and alternative tax instruments in Ecuador. Their focus is pension design, fiscal sustainability, and welfare in one economy. Our focus is to analyze the effect of diverse demographic transitions on equilibrium real interest rates within a harmonized framework for several countries.

Methodologically, we build on the tractable aggregate OLG framework of Papetti (2019). Under constant relative risk aversion (CRRA) preferences and perfect annuity markets, the cohort economy is approximated by an aggregate problem driven by population growth, effective labor growth, and changes in average survival. We introduce demographic paths for 1950 to 2100 and survey based age profiles of labor efficiency for each country, while keeping preferences, technology, and productivity common across economies. Differences across countries can therefore be attributed to demographics and labor force composition. Demographic developments are treated as perfectly anticipated, so the simulations represent low frequency transition paths rather than forecasts of annual interest rates.

Three main results emerge. First, domestic demographic forces generate a persistent decline in equilibrium real rates in all the economies considered. From each country's peak to 2050, the baseline rate falls by approximately 0.8 to 1.6 percentage points, a magnitude similar to model based estimates for advanced economies, where the decline began earlier. Second, the timing differs across countries. Rates decline earlier in Brazil, Chile, Colombia, Mexico, and Peru, whereas sustained declines begin only in the late 2030s or around 2040 in Uruguay and Argentina. The turning points closely follow the dates at which effective labor begins to grow more slowly than population. This reversal comes earlier where fertility fell steeply after the 1960s, because the large cohorts born before the decline are followed by much smaller ones. In Argentina and Uruguay, fertility declined earlier and more gradually, so the age structure changes slowly and effective labor keeps pace with population for longer. Labor force composition is therefore the

main source of variation across countries. Third, the conclusion remains stable with CES production, endogenous labor supply, and PAYGO financing through either labor income or consumption taxes.

The results have two direct implications for policymakers. For monetary authorities, demographic projections provide a disciplined input into medium and long term assessments of the neutral rate. They also caution against imposing one regional trend on countries at different stages of transition. For fiscal authorities, the financing of age related transfers influences how demographics affect labor supply, saving, and interest rates. The closed economy benchmark measures pressure that originates in domestic demographics. Global rates, capital flows, sovereign and currency risk, trend productivity, and financial frictions remain essential for mapping this component into the interest rate observed in each economy.

Population growth has decelerated in all the economies considered since at least the early 1970s. Uruguay and Argentina enter the sample with lower growth and more mature age structures, whereas Brazil, Chile, Colombia, Mexico, and Peru undergo a sharper transition from high to low growth. The temporary increase around 2018 and 2019 in Colombia and Peru largely reflects migration from Venezuela rather than a reversal of the underlying demographic trend¹.

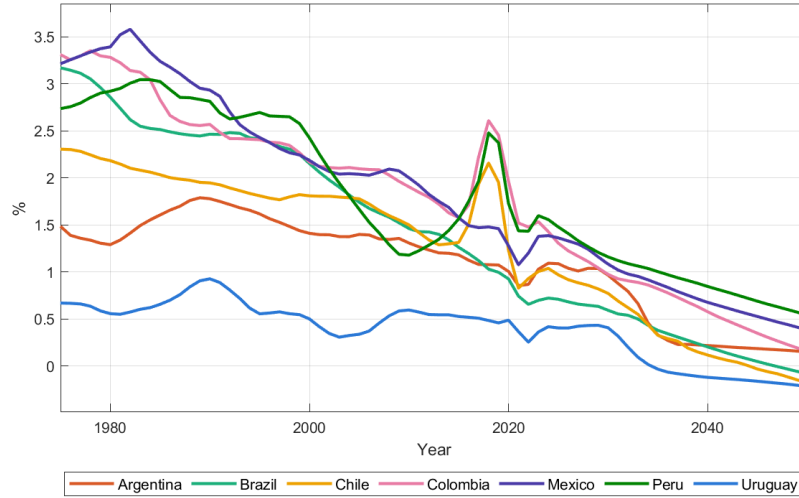
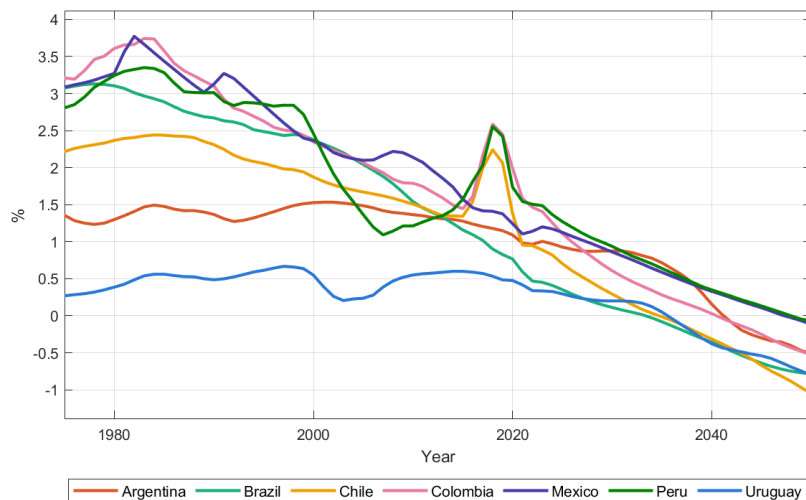


Figure 1: Population growth, 1950 to 2050. Note: Historical estimates and medium variant projections for Argentina, Brazil, Chile, Colombia, Mexico, Peru, and Uruguay. Source: CELADE Population Division of ECLAC and United Nations, 2024 Revision.

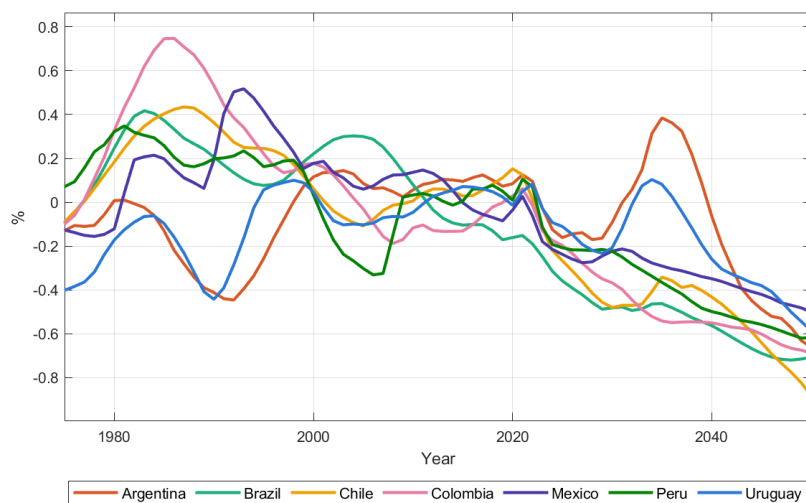
Figure 2 provides intuition for the main mechanism. When effective labor grows faster than population, expanding productive capacity supports capital demand and the

¹Population data include net migration, which also raises the survival probabilities. Appendix E solves the baseline model with an upper bound on survival probabilities to alleviate the temporary movements around the migration from Venezuela in Chile, Colombia, and Peru. Results are robust to this assumption.

equilibrium real rate. When effective labor begins to grow more slowly than population, capital becomes relatively abundant and its marginal product declines. Differences across countries in the timing of this reversal are therefore central to the results.



(a)



(b)

Figure 2: Effective labor growth and its gap relative to population growth. Notes: Panel (a) reports annual percentage growth in labor measured in efficiency units. Panel (b) reports, in percentage points, the difference between annual effective labor growth and annual population growth. Positive values indicate that effective labor is growing faster than population; negative values indicate that it is growing more slowly. Projected values apply the efficiency profiles of Section 3.c, held fixed over time, to the medium variant population projections. Source: Authors' calculations using CELADE Population Division of ECLAC and United Nations, 2024 Revision, and household surveys listed in Table A.1.

The remainder of the paper is organized as follows. Section 2 presents the model.

Section 3 describes the data and calibration. Section 4 reports the quantitative results, Section 5 presents robustness exercises, Section 6 discusses policy implications, and Section 7 concludes.

2 Model

This section presents the closed economy model used for each country. Following Papetti (2019), CRRA preferences and perfect annuity markets allow us to approximate the cohort economy with an aggregate problem under perfect foresight.² Three demographic aggregates drive the transition: population growth (N_t^g), effective labor growth (L_t^g), and growth in average unconditional survival (ζ_t^g). Section 5 relaxes the baseline assumptions about production, labor supply, and pension financing.

2.a Households and demographics

Let j denote age measured from entry into the model. The mass of age- j households evolves according to

$$N_{t,j} = N_{t-1,j-1} s_{t,j} \quad (1)$$

where $s_{t,j}$ is the conditional probability that an individual aged $j-1$ in $t-1$ survives to age j in t . Age $j=0$ corresponds to 14 calendar years. Individuals work through $j_r = 50$ (calendar age 64), retire thereafter, and can live through $J = 85$ (calendar age 99). A household entering in period t solves

$$\begin{aligned} \max_{\{c,a\}} \quad & \sum_{j=0}^J \beta^j \pi_{t+j,j} \frac{c_{t+j,j}^{1-\sigma}}{1-\sigma} \\ \text{subject to} \quad & \\ a_{t+j+1,j+1} = & \frac{(1+r_{t+j})a_{t+j,j}}{s_{t+j,j}} - c_{t+j,j} + y_{t+j,j}, \\ y_{t+j,j} = & (1-\tau_{t+j})w_{t+j}h_{t+j,j}\mathbf{1}\{j \leq j_r\} \\ & + d_{t+j,j}\mathbf{1}\{j > j_r\}, \\ a_{t,0} = & 0, \quad a_{t+J+1,J+1} = 0. \end{aligned} \quad (2)$$

²We also solved a version with limited demographic foresight, in which households know the demographic path k years ahead, and revise their plans every year. Because the representative agent problem uses equal welfare weights, reimposing them in every plan amounts to redistributing resources across cohorts at each revision. Limited foresight raises the equilibrium rate slightly on average, but it leaves the timing of the decline unchanged. Results are available upon request.

Here $\pi_{t+j,j}$ is unconditional survival from entry to age j , $a_{t+j,j}$ denotes assets, and $y_{t+j,j}$ is labor or pension income. A worker of age j earns the net wage per efficiency unit, $(1 - \tau_{t+j})w_{t+j}$, times $h_{t+j,j}$, the labor efficiency of that age in period $t + j$, which combines productivity and labor force participation. Retirees receive the pension $d_{t+j,j}$. As is standard in the literature, we assume that efficiency depends only on age, $h_{t,j} = h_j$, and Section 3.c describes how the profile h_j is estimated from household surveys.

Perfect annuity markets imply that the assets of individuals who die are redistributed among surviving members of the same cohort. This redistribution appears in the survival adjusted return $(1 + r_{t+j})/s_{t+j,j}$ in (2). Accidental bequests remain within the cohort, so no resources are lost at death. The terminal condition $a_{t+J+1,J+1} = 0$ and the absence of a bequest motive imply that households plan to exhaust their assets by the maximum age. The estimated dissaving channel is therefore conditional on complete annuitization and no intended bequests. If older households retain wealth for precautionary or bequest motives, the model may overstate asset decumulation after retirement.

Following Jones (2023), we approximate the cohort allocation with the aggregate problem

$$\max_{\{C_t, K_t\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t \zeta_t \varphi_t \frac{C_t^{1-\sigma}}{1-\sigma} \quad (3)$$

subject to

$$C_t + K_t = (1 - \tau_t) w_t L_t + (1 + r_t) K_{t-1} + T_t \quad (4)$$

where L_t is effective labor supply (exogenous), the working age population weighted by the efficiency profile h_j ,

$$L_t = \sum_{j=0}^{j_r} h_j N_{t,j}, \quad (5)$$

and $\varphi_t = N_t^\sigma$, with $N_t \equiv \sum_{j=0}^J N_{t,j}$.

This aggregate problem approximates the cohort economy. Because all surviving cohorts share the same consumption growth rate, a planner problem with welfare weights fixed for each cohort would reproduce the decentralized allocation exactly. As in Papetti (2019), we set these weights equal across cohorts. This delivers the demographic weight φ_t but abstracts from differences in lifetime resources across cohorts. The survival shifter ζ_t does not come from the aggregation, because survival drops out of individual Euler equations under perfect annuity markets. Following Papetti (2019), it enters the discount

factor to capture in reduced form the effect of longer lives on saving. Appendix C details the derivation.

Problem (3) is therefore a social planner problem with equal welfare weights across cohorts. Formally, the representative household takes prices, taxes, and transfers as given, but with exogenous labor taxes and transfers cancel and there are no distortions, so its allocation coincides with that of the planner. The model does not solve the problems of individual cohorts. With equal weights, consumption per person is the same at every age, $c_{t,j} = C_t/N_t$. When labor supply is endogenous or pensions are financed with a consumption tax (Section 5), taxes distort the allocation, and the representative household problem no longer coincides with that of the planner.

2.b Government and firms

The government operates a balanced budget PAYGO pension system. With replacement parameter $\bar{d}$ and average labor efficiency $\bar{h}$, benefits and the budget constraint are

$$d_t = \bar{d}w_t(1 - \tau_t)\bar{h} \quad (6)$$

$$\tau_t w_t L_t = d_t \sum_{j=j_r+1}^J N_{t,j} = T_t \quad (7)$$

Competitive firms use a Cobb Douglas technology with constant returns to scale,

$$Y_t = A_t K_{t-1}^\psi L_t^{1-\psi} \quad (8)$$

with $\psi \in (0, 1)$. The representative firm maximizes profits in each period:

$$\max_{K_{t-1}, L_t} Y_t - w_t L_t - (r_t + \delta)K_{t-1} \quad (9)$$

with δ the rate of capital depreciation. Profit maximization and competitive markets imply factor demands equal to the marginal product of each factor:

$$w_t = (1 - \psi)A_t K_{t-1}^\psi L_t^{-\psi} \quad (10)$$

$$r_t = \psi A_t K_{t-1}^{\psi-1} L_t^{1-\psi} - \delta \quad (11)$$

The resource constraint is

$$C_t + K_t = (1 - \delta)K_{t-1} + Y_t \quad (12)$$

The demographic path is the model's only exogenous disturbance. It is revealed in 1950 and perfectly anticipated thereafter. Before 1950, the economy is in a steady state with no population growth. This information assumption isolates the demographic transition and should not be interpreted as a literal description of historical expectations.

The model is simulated from 1950 to 2100 using the demographic path for every year, and we report results through 2050. After 2100, demographic growth stops and the economy returns to the steady state with no population growth, so the interest rate converges to $r_{ss} = 1/\beta - 1$ (Appendix D.f). Because households are forward looking, the path through 2050 is computed with the full projected sequence. It is nevertheless insensitive to the terminal assumption: extending the horizon by 100 years with no further demographic growth changes the equilibrium rate by less than half a basis point before 2050.

2.c Equilibrium and transmission channels

An equilibrium in this model is a sequence of prices $\{w_t, r_t\}$ and quantities $\{K_t, C_t, Y_t\}$, given a process for technology A_t and the exogenous demographic processes $\{N_{t,j}, \zeta_t, L_t\}$, such that

1. The representative household solves the problem (3) subject to the budget constraint (4).
2. The fiscal authority sets the tax rate based on (7) and pension transfer (6).
3. The representative firm maximizes profits in (9) subject to (8).
4. The return on physical capital equals the real interest rate, $r_t = \psi A_t \tilde{K}_{t-1}^{\psi-1} - \delta$, so there is no arbitrage between saving and investment.
5. The resource constraint (12) is satisfied.

In equilibrium, $T_t = \tau_t w_t L_t$ from Equation (7). The tax and transfer terms in (4) therefore cancel, and the household budget constraint reduces to the resource constraint (12) after using Equations (10) and (11). Following Papetti (2019), and adapting the characterization to an economy with one production sector, we set productivity to a constant, $A_t = A = 1$ for all t , and summarize the equilibrium with three conditions. The first determines capital per efficiency unit of labor:

$$\tilde{K}_{t-1} = \left\{ \frac{\psi}{r_t + \delta} \right\}^{\frac{1}{1-\psi}} \quad (13)$$

The second is the investment share,

$$\tilde{\iota}_t = \frac{\tilde{I}_t}{\tilde{Y}_t} = \frac{\tilde{K}_t L_{t+1}^g - (1 - \delta) \tilde{K}_{t-1}}{\tilde{K}_{t-1}^\psi} \quad (14)$$

and the third is the Euler equation,

$$\begin{aligned} 1 + r_{t+1} &= \frac{(L_{t+1}^g)^\sigma}{\beta \zeta_{t+1}^g (N_{t+1}^g)^\sigma} \left[\left(\frac{\tilde{Y}_{t+1}}{\tilde{Y}_t} \right) \left(\frac{1 - \tilde{\iota}_{t+1}}{1 - \tilde{\iota}_t} \right) \right]^\sigma \\ &= \frac{1}{\beta \zeta_{t+1}^g} \left[(\bar{L}_{t+1}^g)^{1-\psi} \left(\frac{\bar{K}_t}{\bar{K}_{t-1}} \right)^\psi \left(\frac{1 - \iota_{t+1}}{1 - \iota_t} \right) \right]^\sigma \end{aligned} \quad (15)$$

where $\tilde{Y}_t = \tilde{K}_{t-1}^\psi$, $\tilde{X}_t = X_t/L_t$, $\bar{X}_t = X_t/N_t$, and the investment share is invariant to scaling. Given paths for L_t^g , N_t^g , and ζ_t^g , these conditions determine $\{r_t, \tilde{K}_t, \tilde{\iota}_t\}$ and clarify the four transmission channels.

Labor channel. Slower growth in effective labor raises capital per efficiency unit of labor, other things equal. Diminishing returns then reduce the marginal product of capital and the real interest rate, as shown in (13). Section 5 shows that the direction of this effect is preserved when the elasticity of substitution between capital and labor exceeds one, although its magnitude is smaller.

Survival channel. In the Euler equation (15), an increase in average unconditional survival raises the effective discount factor $\beta \zeta_{t+1}^g$. The representative household becomes more patient, which increases desired saving and places downward pressure on the equilibrium interest rate. Because ζ_{t+1}^g is a reduced form shifter, this channel captures the additional saving that longer lives induce in the cohort economy, not a change in individual patience.

Dissaving channel. As the retired share rises, more households draw down assets to finance consumption. In a closed economy, lower aggregate saving reduces investment and raises the equilibrium interest rate. This channel partly offsets the labor and survival channels but is quantitatively modest in the decomposition below.

Fiscal channel. In the baseline with exogenous labor, the pension tax does not affect the aggregate allocation because taxes and transfers cancel. When labor supply is endogenous, however, the tax burden rises with the old age dependency ratio and lowers the return to work. The resulting reduction in labor input amplifies the downward pressure on the interest rate.

The characterization above holds productivity constant, $A_t = 1$. This isolates the demographic component, but it is a substantive assumption. Labor augmenting productivity growing at a constant rate g_A would multiply the demographic term in the Euler equation (15) by $(1 + g_A)^\sigma$. To a first approximation, this raises the level of the equilibrium rate by about σg_A and leaves the demographic contribution largely unchanged. Time varying productivity would not simply add to the results. Productivity growth and effective labor growth enter jointly through the growth of labor in efficiency units, so a productivity slowdown during the transition would work through the same capital deepening mechanism and interact with the demographic path through capital accumulation. Productivity may also respond to demographics. With learning by doing or other spillovers from capital accumulation, lower investment as labor growth slows would reduce productivity growth and amplify the decline in the equilibrium rate. Labor scarcity may instead induce automation and raise capital demand (Acemoglu and Restrepo, 2022), a mechanism related to the substitution toward capital examined with CES production in Section 5. Evidence for the United States also suggests that population aging lowers labor productivity growth (Maestas et al., 2023). Modeling these feedbacks is beyond the scope of this paper, so our estimates should be read as the demographic component of the equilibrium rate with technology held fixed.

3 Data and calibration

3.a Demographic inputs

The analysis covers Argentina, Brazil, Chile, Colombia, Mexico, Peru, and Uruguay. The sample is not intended to represent every Latin American economy. It combines countries at different stages of the demographic transition for which the population data and household survey variables needed to construct comparable labor efficiency profiles are available. Annual population counts by single year of age for 1950 to 2100 come from the 2024 revision prepared by the CELADE Population Division of ECLAC and the United Nations (CELADE–Population Division of ECLAC and United Nations Population Division, 2024). We use the medium variant projection for every country, which ensures a common demographic source and projection method.

The model population includes individuals aged 14 to 99. Age 14 corresponds to $j = 0$, age 99 to $J = 85$, and age 64 to the last working age, $j_r = 50$. Total population and effective labor are

$$N_t = \sum_{j=0}^J N_{t,j}, \quad L_t = \sum_{j=0}^{j_r} h_j N_{t,j}, \quad (16)$$

where h_j is labor efficiency at age j . Their gross annual growth rates are

$$N_t^g = \frac{N_t}{N_{t-1}}, \quad L_t^g = \frac{L_t}{L_{t-1}}. \quad (17)$$

Effective labor growth differs from population growth for two reasons. The share of the population that is of working age changes, and cohorts move across ages with different labor efficiency values. Relative efficiency is held constant over time, $h_{t,j} = h_j$. Projected effective labor is our own calculation: it applies the profiles h_j estimated in Section 3.c to CELADE's medium variant population projections by single year of age, and no external projection of the labor force is used. The baseline therefore isolates changes in age composition rather than changes in education, health, or technology within age groups.³

The survival input is constructed from unconditional survival probabilities. Let

$$\bar{\pi}_t = \sum_{j=0}^J \pi_{t,j} \frac{N_{t,j}}{N_t} \quad (18)$$

denote average unconditional survival, weighted by the population distribution in period t . Its gross growth rate is

$$\zeta_t^g = \frac{\bar{\pi}_t}{\bar{\pi}_{t-1}} = \frac{\sum_{j=0}^J \pi_{t,j} (N_{t,j}/N_t)}{\sum_{j=0}^J \pi_{t-1,j} (N_{t-1,j}/N_{t-1})}. \quad (19)$$

Figure 3 reports this series for each country. Values above one raise the effective discount factor in the aggregate Euler equation, increase desired saving, and place downward pressure on the equilibrium real rate. The series remains close to one because it combines two opposing effects. Improvements in survival at each age raise average survival. At the same time, population aging places more weight on older ages, for which unconditional survival from entry into the model is mechanically lower. Thus, ζ_t^g is the aggregate survival shifter used by the model and should not be interpreted as a conventional measure of life expectancy.

³The baseline does not capture secular changes in relative productivity by age that arise from differences across cohorts in education, health, or attachment to the labor market.

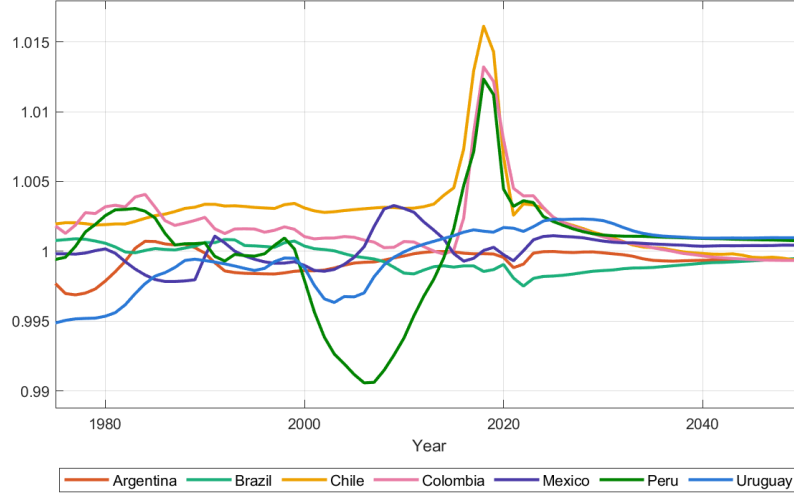


Figure 3: Gross growth in average unconditional survival. Notes: Values above one increase the effective discount factor in the aggregate Euler equation. Average unconditional survival is weighted by population and therefore reflects both improvements in survival at each age and changes in age composition. Source: Authors' calculations using CELADE Population Division of ECLAC and United Nations, 2024 Revision.

3.b Structural parameters

Structural parameters are held constant across countries. This restriction is deliberate. The exercise seeks to identify differences generated by demographic paths and labor efficiency profiles rather than to improve the fit for each country through different preferences or technologies. We set the annual discount factor to $\beta = 0.98$, which implies a steady state real rate of $1/\beta - 1 = 2.04\%$ when population does not grow. The capital share is $\psi = 0.30$, annual depreciation is $\delta = 0.09$, and relative risk aversion is $\sigma = 2$. These parameters primarily determine the level and sensitivity of the rate implied by the model, whereas the demographic inputs determine the timing across countries. Table 1 summarizes the calibration. Appendix Figure A.6 shows that log utility ($\sigma = 1$) changes the amplitude of the responses but not their timing or direction.

Table 1: Baseline calibration

Parameter	Value	Role in the model
ψ	0.30	Capital share in production
β	0.98	Annual discount factor
δ	0.09	Annual depreciation rate
σ	2.00	Relative risk aversion

3.c Labor efficiency profiles

For each country, labor efficiency at age j is measured as average hourly earnings multiplied by the labor force participation rate at that age. Earnings proxy for productivity conditional on employment, while participation captures the extensive margin. We pool survey waves from 2016 to 2019 to reduce sensitivity to cyclical conditions and sampling variation. We then smooth the series with a centered moving average over five ages and normalize its mean over ages 14 to 64 to one within each country. Consistent with the baseline retirement rule, efficiency is set to zero from age 65 onward.

Figure 4 reports the resulting profiles, and Appendix Table A.1 lists the underlying household surveys. Normalization within each country removes differences in average earnings levels. The model therefore uses the shape of each profile and its interaction with the changing population distribution. Differences across countries reflect when cohorts move through working ages with relatively low or high efficiency, not differences in aggregate productivity levels.

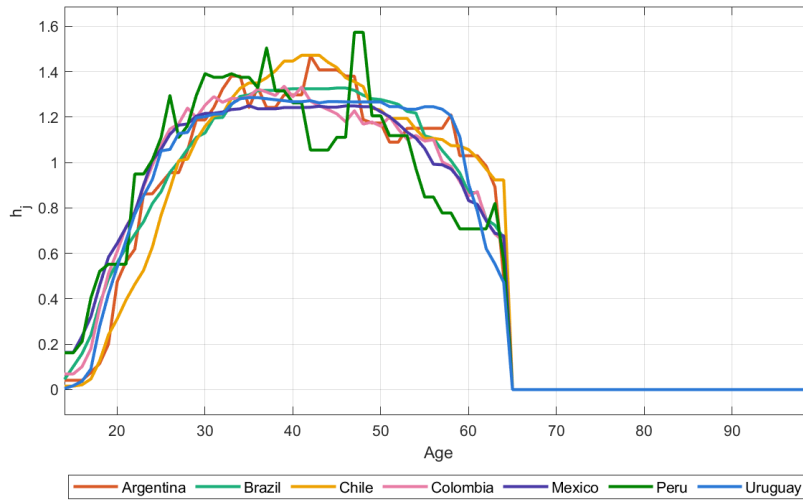


Figure 4: Labor efficiency profiles by age. Notes: Hourly earnings multiplied by labor force participation, averaged from 2016 to 2019, smoothed across five adjacent ages, and normalized to average one over ages 14 to 64. Source: Authors' calculations using the surveys in Appendix Table A.1.

The profiles are estimated from repeated cross sections and therefore combine age effects with differences across cohorts in education, experience, attachment to the labor market, and migration composition. Treating them as fixed profiles over the life cycle is an identifying assumption, not a direct estimate of a pure age effect. Pooling and smoothing reduce sampling noise but cannot separate these components, especially at ages with smaller samples. The baseline nevertheless provides a transparent demographic benchmark. Allowing labor efficiency to vary with cohort education or future labor market

composition would introduce another structural force beyond the demographic transition isolated here.

4 Results

Figure 5 reports the baseline paths and a counterfactual that holds average survival constant ($\zeta_t^g = 1$).⁴ Three results stand out. Demographics eventually reduce the equilibrium rate in every country. The timing differs sharply across the region. Each turning point closely follows the date at which effective labor begins to grow more slowly than population. Consumption smoothing makes the interest rate paths less volatile than the demographic inputs shown in Appendix Figure A.1.

From each country’s peak to 2050, the baseline rate falls by approximately 0.8 to 1.6 percentage points. This magnitude is comparable to model based estimates for advanced economies, although the models and measurement windows differ. [Carvalho et al. \(2016\)](#) find that the demographic transition lowered the equilibrium rate of developed economies by at least 1.5 percentage points between 1990 and 2014. [Gagnon et al. \(2021\)](#) attribute a decline of about 1.25 percentage points since 1980 in the United States to demographic factors, and [Papetti \(2021\)](#) estimates a decline of about 1.4 percentage points in the euro area between the 1980s and 2030. The main difference is timing. In advanced economies, the estimated decline is concentrated between 1980 and 2030, whereas in Latin America it begins later and extends at least to 2050.

Two groups emerge. Brazil, Chile, Colombia, Mexico, and Peru underwent relatively late but rapid demographic transitions. Fertility fell steeply from high levels after the 1960s, producing large cohorts whose passage through working age generated an intense but comparatively brief demographic dividend. These economies reach their highest model implied rates between about 1990 and 2005 and decline persistently thereafter. Effective labor begins to grow more slowly than population first in Brazil, around 2012, then in Colombia and Mexico, around 2022, and in Chile and Peru, around 2023. Capital consequently becomes more abundant relative to labor, and its marginal product declines. By the early 2020s, the average rate for this group is close to or below the steady state value with no population growth, $r_{ss} = 1/\beta - 1 \approx 2.0\%$, and continues to fall toward 2050.

Argentina and Uruguay follow a different path. They enter the sample with more mature age structures that subsequently change at a slower pace, as illustrated by their comparatively high median ages in Figure A.4. Demographic maturity alone does not determine the equilibrium rate. The relevant factor is the pace at which effective labor changes relative to population. The gap between their growth rates remains close to zero in Argentina and Uruguay and displays one final modest increase before becoming

⁴Appendix Figure A.5 shows that starting the transition in 1990 rather than 1950 produces nearly identical results over the common period.

persistently negative. Their interest rates therefore remain comparatively stable into the 2030s. A sustained decline begins around 2040 in Argentina and in the late 2030s in Uruguay. We refer to Brazil, Chile, Colombia, Mexico, and Peru as the rapid transition economies and to Argentina and Uruguay as the gradual transition economies.

Survival channel. Figure 5 compares the baseline, which uses each country's ζ_t^g , with a counterfactual that imposes $\zeta_t^g = 1$. The difference is much smaller than the total decline from the peak to 2050, and its sign and timing vary across countries. When $\zeta_t^g > 1$, the direct effect in the Euler equation raises the effective discount factor, increases desired saving, and lowers the equilibrium rate. However, ζ_t^g is a population weighted average that also reflects changes in age composition. It can fall below one even when survival improves at every age, as explained in Section 3. General equilibrium movements in consumption also affect the difference between the two paths. This counterfactual therefore measures the contribution of the model's aggregate survival shifter, not a uniformly negative effect of improved longevity. Quantitatively, the survival channel is secondary to effective labor growth.

Why is the decline delayed in Argentina and Uruguay? The Euler equation contains the ratio of effective labor growth to population growth, $(L_{t+1}^g/N_{t+1}^g)^\sigma$. In Argentina, effective labor continues to grow at least as fast as population until around 2040. Uruguay follows a similar path, with a somewhat earlier turning point. By contrast, effective labor begins to lag population around 2012 in Brazil and in the early 2020s in Chile, Colombia, Mexico, and Peru. The later reversal in Argentina and Uruguay postpones capital deepening and the associated decline in the marginal product of capital.

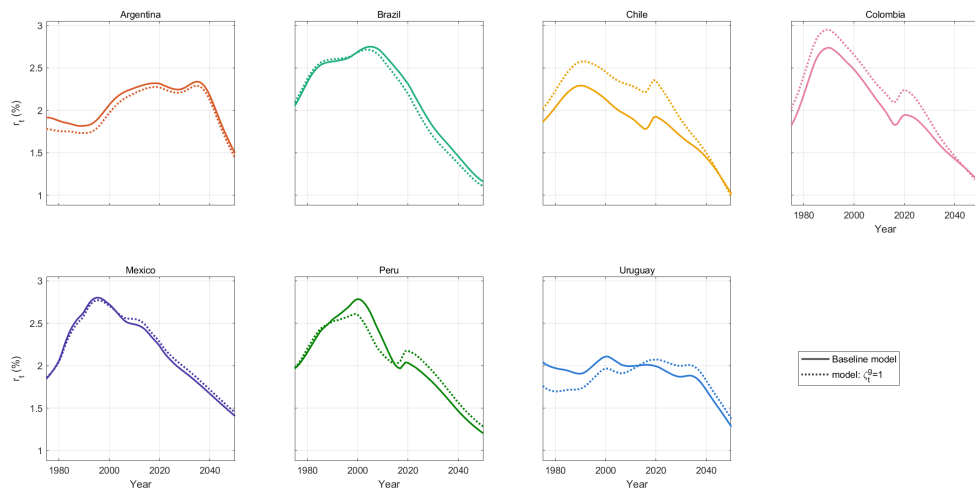
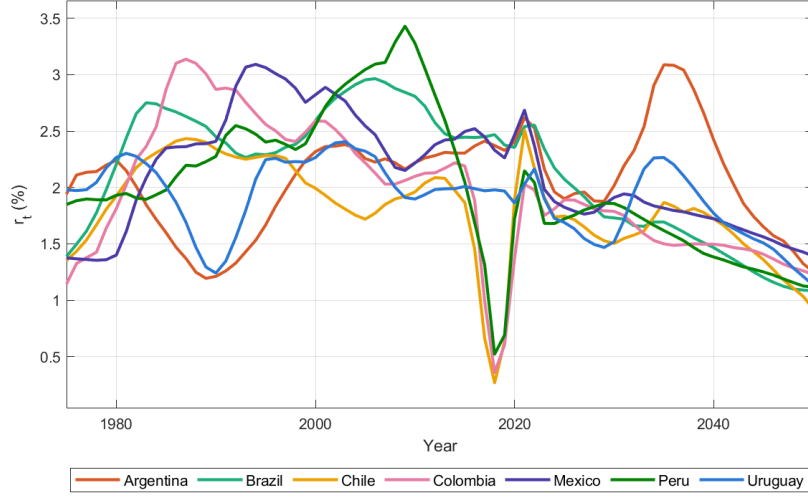


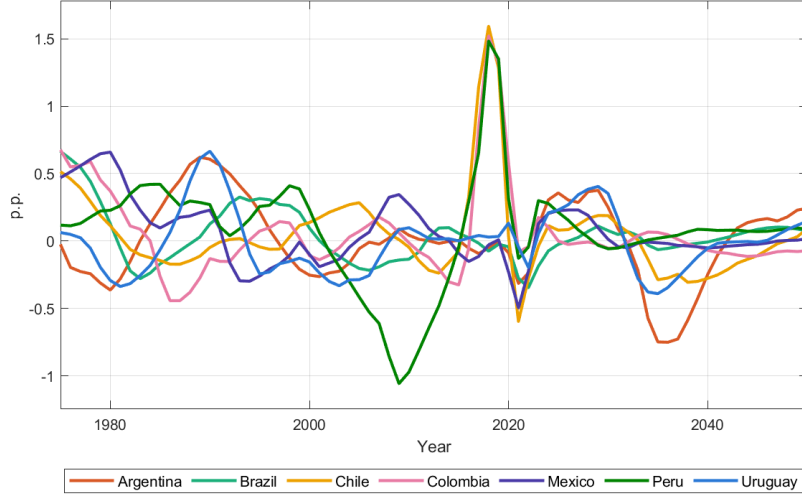
Figure 5: Baseline equilibrium real rates and a counterfactual without changes in average survival. Notes: Rates are annual percentages. The dotted line imposes $\zeta_t^g = 1$ for all t . Source: Authors' calculations.

Appendix Figure A.2 reports output, consumption, and investment growth implied by the model as an internal diagnostic rather than an empirical validation exercise. The paths reflect perfect anticipation of the full demographic sequence and the absence of investment adjustment costs. They may therefore display investment movements that would not arise if demographic shocks, especially unexpected migration, were learned gradually. For this reason, the aggregate paths are not used as independent evidence of model fit.

Dissaving channel. We assess the saving composition effect by holding the investment share $\tilde{t}_t$ at its steady state value. Figure 6.b reports the baseline rate minus the rate in this counterfactual. A positive value means that movements in the investment share raise the equilibrium rate relative to the fixed share path. The contribution is generally only a few basis points, and the counterfactual retains the downward trend of the baseline. Dissaving therefore moderates rather than overturns the dominant effective labor mechanism. Its magnitude depends on the assumptions of no intended bequests and complete annuitization described in Section 2. It should not be interpreted as an empirically validated profile of asset decumulation after retirement.



(a)

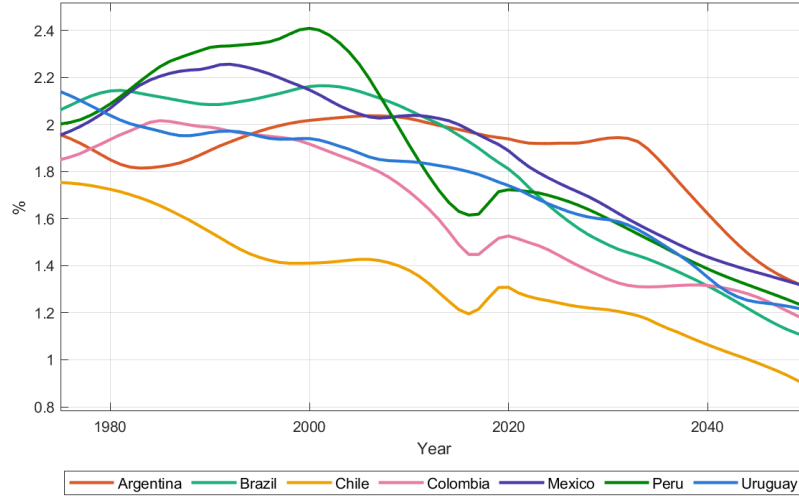


(b)

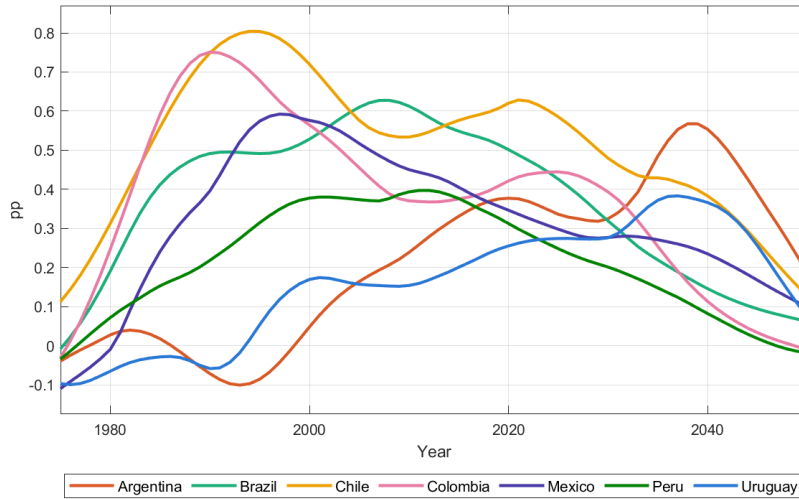
Figure 6: Saving composition counterfactual. Notes: Panel (a) holds the investment share at its steady state value, $\tilde{l}_t = \tilde{l}_{ss}$ for all t . Panel (b) reports the baseline rate minus the fixed share rate. Source: Authors' calculations.

Labor efficiency profile. Figure 7.a assigns unit efficiency to every worker. This removes the interaction between the estimated hump shaped profile by age and the population distribution. Because each country's h_j is normalized to average one over working ages, differences from the baseline arise from composition rather than average productivity. Large cohorts moving from low efficiency youth into high efficiency prime ages temporarily raise effective labor growth and the equilibrium rate. The effect peaks at approximately 0.4 to 0.8 percentage points. It appears earlier in the rapid transition economies and later in Argentina and Uruguay, then fades as those cohorts approach

retirement.



(a)



(b)

Figure 7: Role of labor efficiency by age. Notes: Panel (a) imposes $h_j = 1$ for all $j \leq j_r$. Panel (b) reports the baseline rate minus the rate with flat efficiency. Source: Authors' calculations.

5 Robustness

CES production function

The baseline Cobb Douglas production function imposes a unit elasticity of substitution between capital and labor. Under this specification, lower effective labor raises capital per efficiency unit and reduces its marginal product. We test whether this conclusion changes

when the elasticity is not equal to one. If capital and labor are gross substitutes ($\rho > 1$), firms can respond to labor scarcity by adopting more capital intensive techniques. The resulting increase in capital demand partly offsets the decline in its marginal product.⁵ We replace the baseline production function (8) with

$$Y_t = \left[\psi K_{t-1}^{\frac{\rho-1}{\rho}} + (1 - \psi) L_t^{\frac{\rho-1}{\rho}} \right]^{\frac{\rho}{\rho-1}}$$

where ρ is the elasticity of substitution between capital and labor. The Cobb Douglas case is recovered as $\rho \rightarrow 1$.

Figure 8 compares the baseline ($\rho = 1$) with a specification in which capital and labor are gross substitutes ($\rho = 1.4$). Substitution toward capital raises capital demand when labor becomes scarce, so the interest rate paths are flatter than in the baseline. Nevertheless, demographic forces continue to reduce equilibrium rates in every country from 2020 to 2050. A higher elasticity attenuates the effect but does not reverse it.

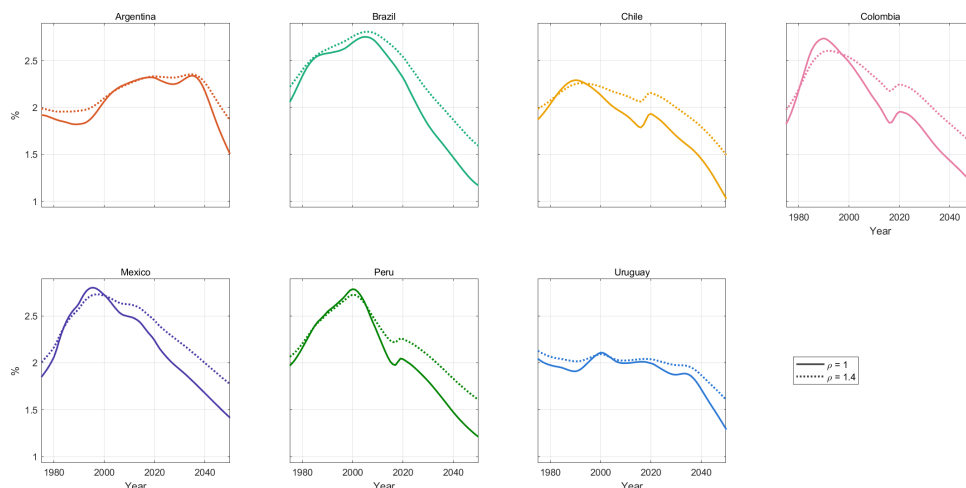


Figure 8: Equilibrium real rates under alternative production functions. Notes: The solid line uses $\rho = 1$ (Cobb Douglas) and the dotted line uses $\rho = 1.4$ (gross substitutes). Rates are annual percentages. Source: Authors' calculations.

Endogenous labor supply

The baseline treats effective labor as exogenous and determined by age structure and the fixed profile h_j . Workers may instead adjust labor supply in response to wages and the tax burden that finances PAYGO pensions. We therefore extend the model so that households choose consumption and labor on the intensive margin, following [Papetti](#)

⁵[Duffy and Papageorgiou \(2000\)](#) find that estimates across countries favor substitutability between capital and labor on average, although the evidence for developing economies is more mixed.

(2019). Preferences are separable in consumption and labor. An individual of age j incurs disutility $\nu_j \ell_{t,j}^{1+\phi}/(1+\phi)$ from supplying a fraction $\ell_{t,j}$ of the time endowment, where ϕ is the inverse Frisch elasticity and ν_j rises sharply near retirement.⁶ In efficiency units of the exogenous labor endowment, $\tilde{X}_t \equiv X_t/L_t$, the representative household solves

$$\max_{\{\tilde{C}_t, l_t, \tilde{K}_t\}} \sum_{t=0}^{\infty} \beta^t \zeta_t \left[\frac{N_t^\sigma}{L_t^{\sigma-1}} \frac{\tilde{C}_t^{1-\sigma}}{1-\sigma} - \tilde{\nu}_t \frac{l_t^{1+\phi}}{1+\phi} \right] \quad (20)$$

subject to

$$\tilde{C}_t + L_{t+1}^g \tilde{K}_t = (1 - \tau_t) w_t l_t + (1 + r_t) \tilde{K}_{t-1} + \tilde{T}_t, \quad (21)$$

where $0 < l_t < 1$ is the fraction of the aggregate efficiency endowment supplied to firms, so effective labor input is $l_t L_t$. The term $\tilde{T}_t$ is the aggregate pension transfer in efficiency units. In equilibrium, $\tilde{T}_t = \tau_t w_t l_t$, so transfers cancel labor tax revenue in the aggregate budget constraint. The exogenous wedge

$$\tilde{\nu}_t \equiv \left[\sum_{j=0}^{j_r} N_{t,j} \left(\frac{h_j}{L_t} \right)^{1+\frac{1}{\phi}} \nu_j^{-\frac{1}{\phi}} \right]^{-\phi} \quad (22)$$

aggregates individual disutility weights using cohort sizes and relative efficiencies, under equal welfare weights across cohorts. Because ν_j rises with age, an older workforce increases $\tilde{\nu}_t$ and makes a given amount of effective labor more costly to supply.

In this environment, the government budget affects the equilibrium allocation. Pension benefits follow the baseline rule, $d_t = \bar{d} w_t (1 - \tau_t) \bar{h}$, and the balanced budget condition (7) determines the tax rate:

$$\tau_t w_t l_t = d_t \Omega_t \implies \tau_t = \frac{\bar{d} \bar{h} \Omega_t}{l_t + \bar{d} \bar{h} \Omega_t}, \quad \Omega_t \equiv \frac{\sum_{j=j_r+1}^J N_{t,j}}{L_t}, \quad (23)$$

where Ω_t is the effective old age dependency ratio, defined as retirees per efficiency unit of the labor endowment. The term $\bar{h}$ is the simple average of h_j over working ages and equals one under the normalization in Section 3. Aging raises Ω_t and therefore the tax burden. Higher taxes reduce the return to work through the intratemporal condition (24). This response creates an endogenous feedback from demographics to effective labor in addition to the direct change in workforce composition.

With the labor choice, equilibrium is characterized by the household's intratemporal

⁶Following Papetti (2019), $\nu_j = b_0 + b_1 \frac{j}{J+1} \Phi\left(\frac{j-(J+1)b_2}{(J+1)b_3}\right)$, where $\Phi(\cdot)$ is the standard normal cumulative distribution function and $(b_0, b_1, b_2, b_3) = (4, 17, 0.6, 0.02)$. The profile is flat through young and prime ages and rises sharply around age 65.

and intertemporal conditions, the firm's optimality conditions, and the resource constraint. The intratemporal condition equates the marginal disutility of work to the marginal utility value of the net wage:

$$\tilde{\nu}_t l_t^\phi = \frac{N_t^\sigma}{L_t^{\sigma-1}} \tilde{C}_t^{-\sigma} (1 - \tau_t) w_t. \quad (24)$$

The aggregate Euler equation can be written in terms of consumption growth as

$$1 + r_{t+1} = \frac{(L_{t+1}^g)^\sigma}{\beta \zeta_{t+1}^g (N_{t+1}^g)^\sigma} \left(\frac{\tilde{C}_{t+1}}{\tilde{C}_t} \right)^\sigma, \quad (25)$$

and the single representative firm, which now employs the effective labor input $l_t L_t$, implies

$$\tilde{Y}_t = \tilde{K}_{t-1}^\psi l_t^{1-\psi}, \quad w_t = (1 - \psi) \left(\frac{\tilde{K}_{t-1}}{l_t} \right)^\psi, \quad \tilde{K}_{t-1} = l_t \left(\frac{\psi}{r_t + \delta} \right)^{\frac{1}{1-\psi}}, \quad (26)$$

so that hours scale the optimal amount of capital per unit of the exogenous labor endowment. Together with the resource constraint,

$$\tilde{C}_t = \tilde{Y}_t + (1 - \delta) \tilde{K}_{t-1} - L_{t+1}^g \tilde{K}_t, \quad (27)$$

and the tax rule (23), these conditions determine prices, consumption, capital, labor, and the tax rate. The exogenous inputs are the baseline demographic paths, the effective old age dependency ratio Ω_t , and the disutility wedge $\tilde{\nu}_t$. The aggregate approximation that delivers Equations (20) and (21) follows Papetti (2019) and is omitted.

We set the inverse Frisch elasticity to $\phi = 2$ and retain the replacement rate $\bar{d} = 0.45$. The disutility profile uses the normal CDF specification and parameters in Papetti (2019); its scale keeps the chosen labor fraction below one throughout the transition. We solve the model with the same steady state boundary conditions and algorithm as in the baseline.

The steady state labor fraction is computed separately for each country. We require the initial steady state to reproduce the baseline rate $r_{ss} = 1/\beta - 1$. The firm's conditions in (26) then determine capital intensity, and the labor condition (24) determines l_{ss} from the initial age distribution and efficiency profile. The implied values range from 0.66 in Mexico and Peru to 0.71 in Chile. Because l_t is an intensive margin choice rather than a measured participation rate, these levels are not direct empirical targets. During the displayed transition, l_t remains between approximately 0.73 and 0.79 (Figure 10).

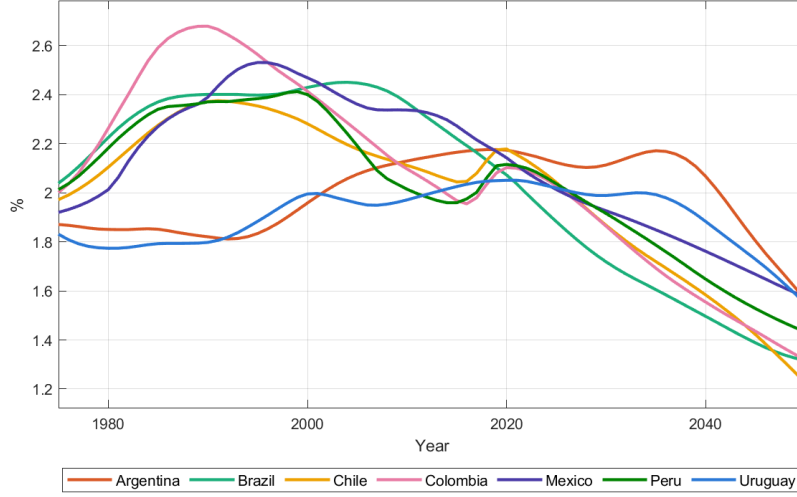


Figure 9: Equilibrium real rates with endogenous labor supply. Notes: Rates are annual percentages. Source: Authors' calculations.

Figure 9 shows that endogenous labor supply preserves the main result. Every country has a lower equilibrium rate by 2050, and the timing across countries remains similar to the baseline. Figure 10 reports labor supply l_t and the PAYGO tax rate τ_t . Labor supply is not monotonic because wages, workforce composition, and taxation move simultaneously, but it generally weakens during periods of rapid aging. The tax rate rises with the pension burden, particularly in Brazil and Chile. A higher tax reduces the return to work, while a smaller labor base requires a higher tax to balance the pension budget. This feedback amplifies the demographic effect but does not determine it.

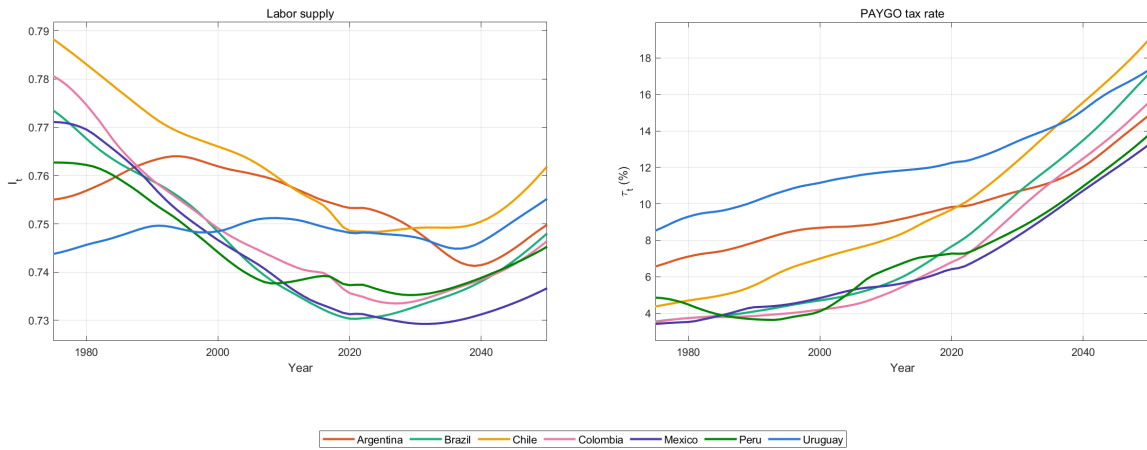


Figure 10: Labor supply and PAYGO taxation with endogenous labor. Notes: The left panel reports labor supply l_t and the right panel the labor income tax rate τ_t , in percent. Source: Authors' calculations.

Consumption tax financing

The baseline PAYGO system is financed through a tax on labor income. As an alternative, we finance pension benefits through a consumption tax τ_t^c . A changing consumption tax introduces the intertemporal wedge $(1 + \tau_{t+1}^c)/(1 + \tau_t^c)$ into the aggregate Euler equation, as derived in Appendix C. The tax adjusts each period to balance the pension budget. As aging raises the ratio of retirees to workers, the tax tends to rise and the wedge places upward pressure on the equilibrium interest rate relative to the baseline.

Appendix B states the household problem, and Appendix D derives the equilibrium. Here we collect the resulting conditions. We set $A = 1$ and express quantities per efficiency unit of labor, $\tilde{X}_t \equiv X_t/L_t$. Five equations determine $\{r_t, w_t, \tilde{K}_t, \tilde{C}_t, \tau_t^c\}$. The firm's conditions relate the interest rate to capital intensity and the wage:

$$\tilde{K}_{t-1} = \left(\frac{\psi}{r_t + \delta}\right)^{\frac{1}{1-\psi}}, \quad w_t = (1 - \psi) \left(\frac{\psi}{r_t + \delta}\right)^{\frac{\psi}{1-\psi}}; \quad (28)$$

The resource constraint determines consumption:

$$\tilde{C}_t = \tilde{K}_{t-1}^\psi + (1 - \delta)\tilde{K}_{t-1} - L_{t+1}^g \tilde{K}_t; \quad (29)$$

The aggregate Euler equation contains the consumption tax wedge:

$$1 + r_{t+1} = \frac{(L_{t+1}^g)^\sigma}{\beta \zeta_{t+1}^g (N_{t+1}^g)^\sigma} \left(\frac{\tilde{C}_{t+1}}{\tilde{C}_t}\right)^\sigma \frac{1 + \tau_{t+1}^c}{1 + \tau_t^c}; \quad (30)$$

The tax rate balances the pension budget in each period:

$$\tau_t^c = \bar{d} \bar{h} \frac{w_t}{\tilde{C}_t} \Omega_t = \frac{\bar{d} \bar{h} w_t \sum_{j=j_r+1}^J N_{t,j}}{\tilde{C}_t}, \quad (31)$$

The exogenous paths are $\{L_t^g, N_t^g, \zeta_t^g, \Omega_t\}$, where $\Omega_t \equiv N_t^{\text{ret}}/L_t$ is the effective old age dependency ratio and $N_t^{\text{ret}} \equiv \sum_{j=j_r+1}^J N_{t,j}$ is the retired population. Relative to the baseline, the new element is the wedge $(1 + \tau_{t+1}^c)/(1 + \tau_t^c)$ in (30). A constant consumption tax would not distort the intertemporal margin. Changes in the tax during the demographic transition affect the equilibrium rate.

Figure 11 reports the equilibrium interest rate and consumption tax rate for each country. The interest rate retains its downward trend in all seven economies, so the choice of tax base does not change the qualitative result. Rates are somewhat higher than in the baseline, especially from 2020 to 2050, because the consumption tax wedge contributes positively to the Euler equation. The tax generally rises during the transition, although temporary declines occur when wages or consumption grow enough to offset the increase in the retired population.

The balanced budget condition (31) implies $\tau_t^c \propto N_t^{\text{ret}}/C_t$. The tax must rise when

the retired population grows relative to aggregate consumption. Brazil and Chile, which age earlier and more rapidly, display the largest increases over the projection horizon. A rising tax makes current consumption relatively cheaper than future consumption and therefore raises the equilibrium interest rate through (30). This fiscal effect moderates but does not reverse the decline produced by slower effective labor growth and changes in survival.

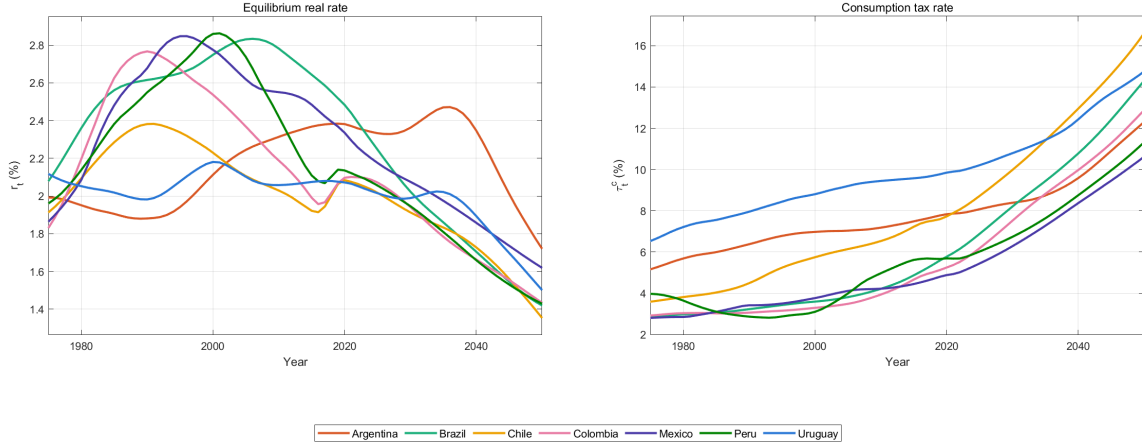


Figure 11: Equilibrium real rates and consumption tax rates under consumption tax pension financing. Notes: The left panel reports r_t and the right panel τ_t^c , both in percent; $\bar{d} = 0.45$. Source: Authors' calculations.

6 Policy implications

The rates produced by the model should not be mapped mechanically into policy rates. Their value is to provide an observable and forward looking component that can discipline estimates of the neutral real rate. Most empirical methods treat low frequency movements in the neutral rate as latent and recover them gradually and with considerable uncertainty (Laubach and Williams, 2003; Holston et al., 2017; Juárez, 2023). Central banks could use demographic paths as priors, conditioning variables, or external checks in semistructural models. This information can help distinguish predictable demographic movements from changes attributed to productivity, global financial conditions, or risk premia.

This distinction matters for assessments of the monetary stance. If the domestic demographic component is declining, a fixed historical or regional benchmark may understate the degree of monetary restraint. This risk is not uniform across the region. Downward pressure appears earlier in Brazil, Chile, Colombia, Mexico, and Peru than in Argentina and Uruguay. National estimates should therefore allow for different demographic turning points instead of imposing one Latin American trend. The result remains a component decomposition, not a forecast of the observed neutral rate. Global real rates, sovereign and currency risk, investment demand, and trend productivity can offset or dominate the

demographic contribution in particular periods. A rising estimate of the overall neutral rate is thus compatible with demographic pressure in the opposite direction.

A lower equilibrium real rate can also reduce the conventional monetary policy buffer. For a given inflation target, a persistent decline in the real neutral rate lowers the nominal rate consistent with a neutral stance and reduces its distance from the effective lower bound. Nominal rates in Latin America may remain above those in advanced economies because inflation expectations and country risk differ. The relevant comparison, however, is with the rate that would prevail without demographic change. The projected decline can still reduce policy space and increase the value of anchored expectations, credible frameworks, and contingency planning. Because the demographic force is gradual, it is relevant for medium and long term strategy rather than for high frequency policy decisions.

The pension exercises reveal a fiscal and monetary interaction. Population aging raises the resources required to finance PAYGO transfers, while the tax base determines how this burden affects labor supply and consumption over time. A tax on labor income can reinforce the contraction in effective labor by reducing the return to work. Consumption tax financing introduces an intertemporal wedge that partly offsets the decline in the equilibrium rate. The exercises do not identify an optimal pension or tax reform. They show, however, that pension financing affects the macroeconomic environment in which monetary policy operates. Central bank projections and fiscal sustainability exercises should therefore use consistent assumptions about population, retirement, participation, benefits, and taxation.

The dominance of the effective labor channel identifies the most informative variables for policy scenarios. Labor force participation, retirement ages, migration, health, and human capital can change effective labor even when the population projection is unchanged. Policies that affect these margins may influence both potential output and the demographic component of the equilibrium rate. Our simulations do not quantify specific reforms and should not be used to rank them. They can instead support scenarios that combine alternative fertility and migration paths with assumptions about participation, retirement, productivity, and pension financing.

Demographic information can narrow uncertainty about one component of the neutral rate, but it should not create false precision about the overall concept. Fertility, mortality, and especially migration projections are revised over time. The closed economy model also abstracts from the international redistribution of saving and investment emphasized by [Carvalho et al. \(2025\)](#). The appropriate policy output is therefore a range of demographic paths embedded in a broader set of neutral rate estimates, not a single point estimate. Used in this way, the model provides a transparent long term anchor while preserving the judgment and model diversity required for operational monetary policy.

7 Conclusion

This paper quantifies the domestic demographic contribution to equilibrium real interest rates in seven Latin American economies. We combine harmonized population projections and labor efficiency profiles from household surveys in a tractable overlapping generations model. Common preferences, technology, and productivity isolate the role of demographics and labor force composition in explaining differences across countries.

From each country's peak to 2050, the baseline equilibrium rate falls by approximately 0.8 to 1.6 percentage points. The reversal of the demographic dividend is central to this result. Once effective labor grows more slowly than population, capital becomes more abundant relative to labor and its marginal product declines. Changes in average survival and asset decumulation after retirement have smaller effects that partly offset one another. The timing is national rather than regional. The decline begins earlier in Brazil, Chile, Colombia, Mexico, and Peru, whereas sustained downward pressure emerges only in the late 2030s or around 2040 in Uruguay and Argentina.

The findings remain stable with alternative production functions, endogenous labor supply, and different methods of financing PAYGO pensions. The broader conclusion is not simply that aging lowers rates. The speed and composition of the demographic transition determine when this pressure becomes relevant. Treating Latin America as one demographic block would obscure the variation that is most useful for national policy analysis.

The model deliberately isolates one component of the equilibrium real rate. International capital flows, productivity, sovereign and currency risk, and global interest rates remain essential for explaining observed domestic rates. Uncertainty about fertility and migration also limits the precision of long term projections. Future work could embed the countries in an open economy framework, introduce demographic uncertainty and investment adjustment costs, allow incomplete annuitization and bequest motives, and model changes across cohorts in labor efficiency and retirement behavior. These extensions would refine the estimated magnitude and transmission. The present results establish domestic demographics as a systematic and measurable component of Latin America's changing interest rate environment.

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A Appendix

A.a Figures

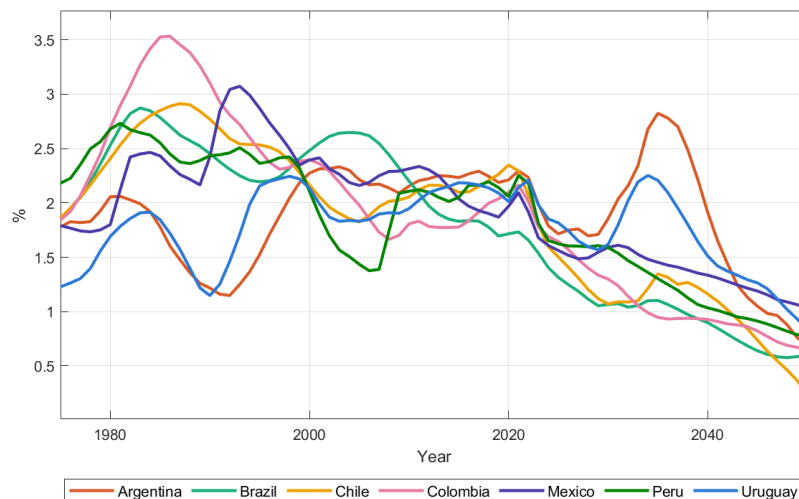


Figure A.1: Raw demographic component of the Euler equation, $[(L_t^g)^\sigma / (\beta \zeta_t^g (N_t^g)^\sigma)] - 1$. Source: Authors' calculations.

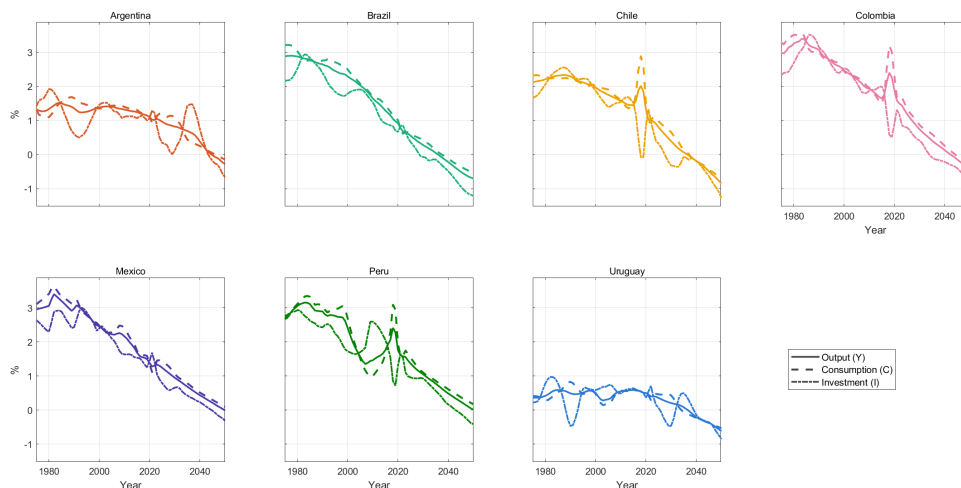


Figure A.2: Growth of aggregate output, consumption, and investment implied by the model. Notes: Annual percentage changes; output is solid, consumption dashed, and investment uses a dash and dot pattern. These paths are an internal model diagnostic, not an empirical validation exercise, because demographics are perfectly anticipated and investment is not subject to adjustment costs. Source: Authors' calculations.

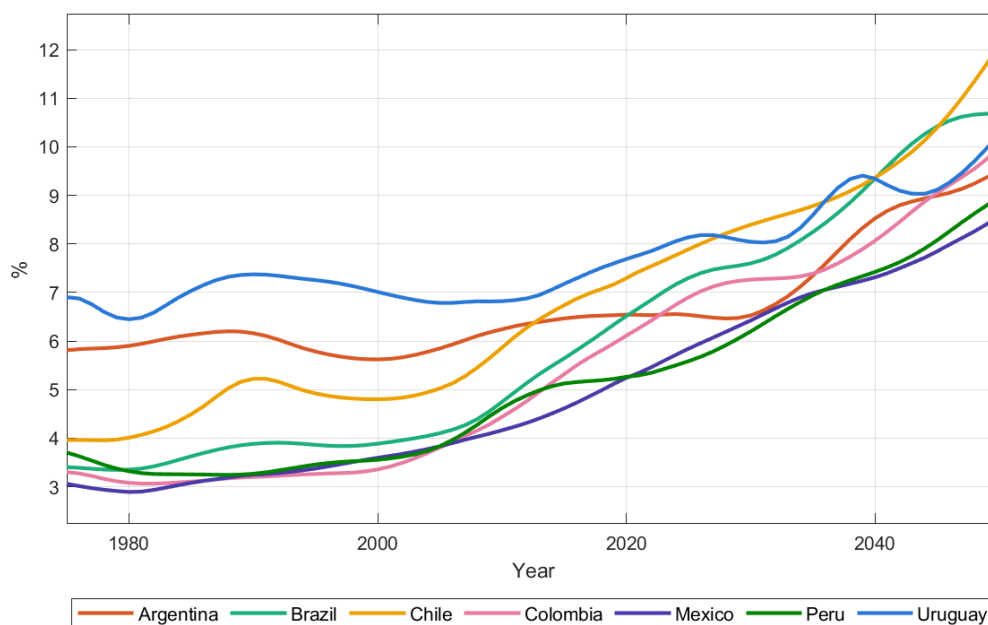


Figure A.3: Population aged 60 to 64 as a share of the population aged 14 to 64. Source: Authors' calculations using CELADE Population Division of ECLAC and United Nations, 2024 Revision.

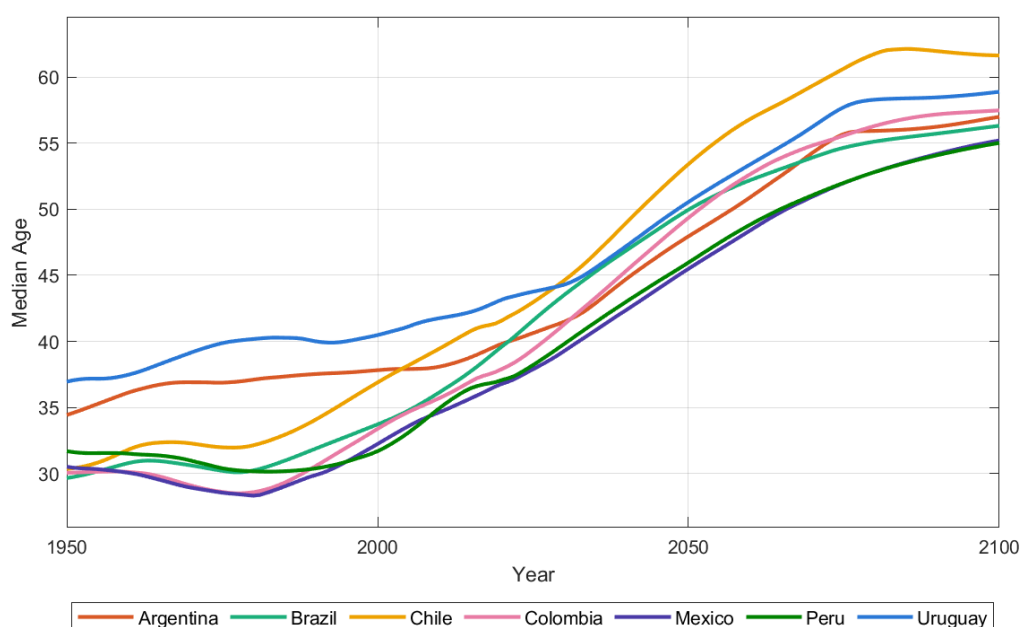


Figure A.4: Median age of the population aged 14 to 99. Source: Authors' calculations using CELADE Population Division of ECLAC and United Nations, 2024 Revision.

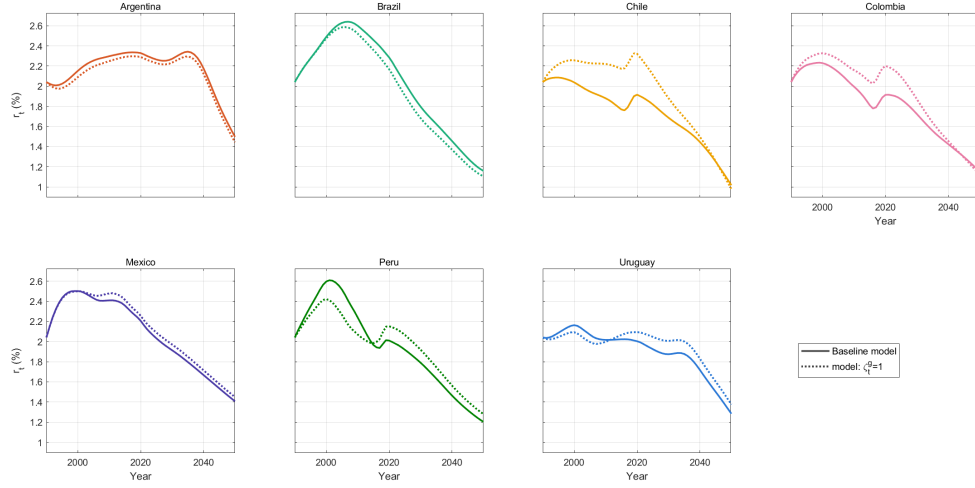


Figure A.5: Baseline rates and the counterfactual with constant average survival when the transition starts in 1990. Source: Authors' calculations.

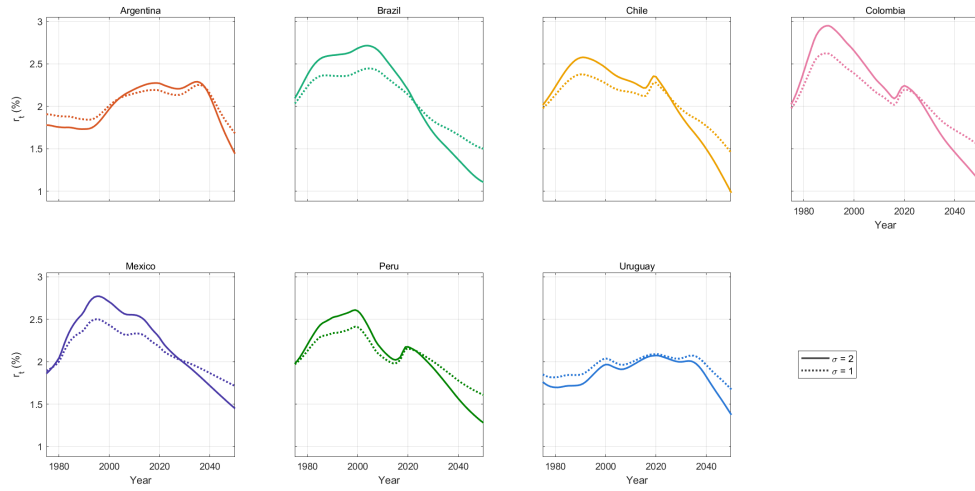


Figure A.6: Baseline equilibrium real rates under log utility ($\sigma = 1$) and the benchmark calibration ($\sigma = 2$). Source: Authors' calculations.

A.b Data sources

Table A.1: Household survey data sources

Country	Survey
Argentina	Encuesta Permanente de Hogares
Brazil	Pesquisa Nacional por Amostra de Domicilios Continua
Chile	Encuesta Suplementaria de Ingresos
Colombia	Gran Encuesta Integrada de Hogares
Mexico	Encuesta Nacional de Ocupación y Empleo
Peru	Encuesta Nacional de Hogares
Uruguay	Encuesta Continua de Hogares

Note: The calculations use survey waves from 2016 to 2019.

B Model with consumption taxes

This appendix describes the version in which a consumption tax, rather than a tax on labor income, finances pension benefits.

B.a Households

A household that enters the model at age $j = 0$ chooses consumption and assets for each remaining period of life. With CRRA period utility, the problem is

$$\max_{\{c_{t+j,j}, a_{t+j+1,j+1}\}} \sum_{j=0}^J \beta^j \pi_{t+j,j} \frac{(c_{t+j,j})^{1-\sigma}}{1-\sigma} \quad (\text{B.32})$$

subject to

$$a_{t+j+1,j+1} = \frac{a_{t+j,j}(1+r_{t+j})}{s_{t+j,j}} - (1+\tau_{t+j}^c) c_{t+j,j} + y_{t+j,j}, \quad (\text{B.33})$$

$$y_{t+j,j} = w_{t+j} h_j \mathbf{1}\{j \leq j_r\} + d_{t+j} \mathbf{1}\{j > j_r\}, \quad (\text{B.34})$$

$$a_{t+J+1,J+1} = 0, \quad a_{t,0} = 0. \quad (\text{B.35})$$

The difference from [Papetti \(2019\)](#) is the placement of the tax. Gross labor income $w_{t+j} h_j$ is untaxed, while each unit of consumption costs $1 + \tau_{t+j}^c$ units of the good.

B.b Government

The pension benefit and the balanced budget condition are

$$d_t = \bar{d} w_t \bar{h}, \quad (\text{B.36})$$

$$\tau_t^c C_t = d_t \sum_{j=j_r+1}^J N_{t,j} = T_t, \quad (\text{B.37})$$

where $C_t \equiv \sum_{j=0}^J c_{t,j} N_{t,j}$ is aggregate consumption, w_t is the economywide hourly real wage, and $T_t = d_t \sum_{j=j_r+1}^J N_{t,j}$ is the aggregate pension transfer. The left side of (B.37) is total consumption tax revenue. A balanced budget determines the tax rate:

$$\tau_t^c = \frac{\bar{d} w_t \bar{h} \sum_{j=j_r+1}^J N_{t,j}}{C_t}. \quad (\text{B.38})$$

The consumption tax is positive because pensions must be financed. With exogenous labor supply, it does not affect a static labor choice, but changes in the tax during the demographic transition affect intertemporal consumption decisions. Equation (B.36) indexes benefits to the gross wage w_t , whereas the baseline model in (6) indexes them to the net wage $(1 - \tau_t)w_t$. These definitions are consistent because gross and net wages coincide when pensions are financed by a consumption tax. The firm's problem, market clearing conditions, shocks, and equilibrium are defined as in the baseline model.

C Aggregate representation of the OLG economy

Following Papetti (2019), this section shows how the decentralized OLG allocation is approximated by the problem of an infinitely lived agent, identifies which steps are exact, and makes explicit how the consumption tax enters that representation.

C.a Individual optimality with a consumption tax

Attach a multiplier $\mu_{t+j,j}$ to the budget constraint for period j in (B.33). The first order conditions of the problem defined by Equations (B.32) to (B.35) are

$$[c_{t+j,j}] : \quad \beta^j \pi_{t+j,j} c_{t+j,j}^{-\sigma} = \mu_{t+j,j} (1 + \tau_{t+j}^c), \quad (\text{C.1})$$

$$[a_{t+j+1,j+1}] : \quad \mu_{t+j,j} = \mu_{t+j+1,j+1} \frac{1 + r_{t+j+1}}{s_{t+j+1,j+1}}. \quad (\text{C.2})$$

Combining (C.1) for ages j and $j + 1$ with (C.2), and using the recursion $\pi_{t+j+1,j+1} = \pi_{t+j,j} s_{t+j+1,j+1}$, yields the individual Euler equation

$$\frac{c_{t+j,j}^{-\sigma}}{1 + \tau_{t+j}^c} = \beta (1 + r_{t+j+1}) \frac{c_{t+j+1,j+1}^{-\sigma}}{1 + \tau_{t+j+1}^c}. \quad (\text{C.3})$$

Writing it in calendar time t for an individual aged j (relabel $t + j \equiv t$),

$$\frac{c_{t,j}^{-\sigma}}{1 + \tau_t^c} = \beta (1 + r_{t+1}) \frac{c_{t+1,j+1}^{-\sigma}}{1 + \tau_{t+1}^c}, \quad j = 0, \dots, J - 1. \quad (\text{C.4})$$

The wedge $(1 + \tau_t^c)/(1 + \tau_{t+1}^c)$ is the only new term relative to the model with a labor tax in Papetti (2019). A constant consumption tax leaves the intertemporal margin undistorted. A changing tax, which arises as aging changes the pension bill in (B.38), alters consumption growth.

C.b A common consumption growth factor

The bracketed term on the right side of (C.4) does not depend on the cohort index j . The gross growth rate of consumption is therefore identical across all surviving cohorts:

$$\frac{c_{t+1,j+1}}{c_{t,j}} = g_{t+1} \equiv \left[\beta (1 + r_{t+1}) \frac{1 + \tau_t^c}{1 + \tau_{t+1}^c} \right]^{1/\sigma} \quad \text{for all } j. \quad (\text{C.5})$$

This CRRA property underlies the aggregation. Every survivor scales consumption by the same factor g_{t+1} , so the shape of the consumption profile across cohorts is preserved and only its level changes.

C.c Aggregation of the budget constraints

Let aggregate household assets carried into period t be $\mathcal{A}_t \equiv \sum_{j=1}^J a_{t,j} N_{t-1,j-1}$, the assets chosen in $t-1$ by the households alive in that period. Multiply the individual budget (B.33) (in calendar time) by $N_{t,j}$ and sum over j . The left side gives $\sum_{j=0}^J a_{t+1,j+1} N_{t,j} = \mathcal{A}_{t+1}$, since $a_{t+1,J+1} = 0$. Because entrants hold no assets ($a_{t,0} = 0$), the annuity return term summed over cohorts gives

$$\sum_{j=0}^J \frac{a_{t,j}(1 + r_t)}{s_{t,j}} N_{t,j} = (1 + r_t) \sum_{j=1}^J a_{t,j} \frac{N_{t,j}}{s_{t,j}},$$

and the cohort law of motion $N_{t,j} = N_{t-1,j-1} s_{t,j}$ yields $N_{t,j}/s_{t,j} = N_{t-1,j-1}$. The expression therefore equals $(1 + r_t) \sum_{j=1}^J a_{t,j} N_{t-1,j-1} = (1 + r_t) \mathcal{A}_t$.⁷ Collecting terms and using (5)

⁷Under perfect annuity markets, the assets of cohort members who die are redistributed among survivors. From an aggregate perspective, the entire stock $\mathcal{A}_t$ earns r_t .

and (B.37) gives

$$\mathcal{A}_{t+1} = (1 + r_t) \mathcal{A}_t - (1 + \tau_t^c) C_t + w_t L_t + T_t. \quad (\text{C.6})$$

In equilibrium, household assets equal the capital stock, $\mathcal{A}_t = K_{t-1}$ and $\mathcal{A}_{t+1} = K_t$. Equation (C.6) therefore becomes the representative agent budget constraint

$$(1 + \tau_t^c) C_t + K_t = w_t L_t + (1 + r_t) K_{t-1} + T_t. \quad (\text{C.7})$$

Substituting the government budget $T_t = \tau_t^c C_t$ from (B.37) cancels the tax at the aggregate level and recovers the economywide resource constraint

$$C_t + K_t = w_t L_t + (1 + r_t) K_{t-1} = Y_t + (1 - \delta) K_{t-1}, \quad (\text{C.8})$$

where the last equality uses constant returns ($w_t L_t + (r_t + \delta) K_{t-1} = Y_t$). Thus, the consumption tax is a pure intertemporal wedge that redistributes from consumers to pensioners and does not waste resources.

C.d The representative agent problem

Following Jones (2023), we approximate the individual problems with the problem of an infinitely lived representative agent. The approximation has two steps (Papetti, 2019). First, because all surviving cohorts share the growth factor (C.5), relative consumption across cohorts is constant over time, and a planner problem with welfare weights fixed for each cohort reproduces the decentralized allocation exactly. Second, these weights are set equal across cohorts. This step is an approximation, because the weights that reproduce the decentralized allocation depend on each cohort's lifetime resources, which differ along the transition. The agent discounts the future by $\beta \zeta_t$ and weights each period by the demographic factor φ_t :

$$\varphi_t = \left[\sum_{j=0}^J N_{t,j} (\lambda_j)^{1/\sigma} \right]^\sigma \stackrel{\lambda_j=1}{=} N_t^\sigma, \quad N_t \equiv \sum_{j=0}^J N_{t,j}, \quad (\text{C.9})$$

where the welfare weights λ_j are equal across cohorts and normalized to one. With equal weights, consumption is the same at every age, $c_{t,j} = C_t/N_t$. The survival shifter ζ_t accumulates changes in average unconditional survival. It is not part of the aggregation, since survival drops out of the individual Euler equation (C.4) under perfect annuity markets. As in Papetti (2019), it is added to the discount factor to capture in reduced form the effect of longer lives on saving in the cohort economy. With $\bar{\pi}_t \equiv \sum_{j=0}^J \pi_{t,j} (N_{t,j}/N_t)$, we set

$$\zeta_t = \frac{\bar{\pi}_t}{\bar{\pi}_0}, \quad \text{so that} \quad \zeta_{t+1}^g \equiv \frac{\zeta_{t+1}}{\zeta_t} = \frac{\bar{\pi}_{t+1}}{\bar{\pi}_t}, \quad (\text{C.10})$$

which is the ζ_t^g defined in Section 3. When $\zeta_t^g > 1$, the effective discount factor rises and the representative agent becomes more patient. The agent solves

$$\max_{\{C_t, K_t\}} \sum_{t=0}^{\infty} \beta^t \zeta_t \varphi_t \frac{C_t^{1-\sigma}}{1-\sigma} \quad \text{s.t.} \quad (1 + \tau_t^c) C_t + K_t = w_t L_t + (1 + r_t) K_{t-1} + T_t, \quad (\text{C.11})$$

taking prices, the transfer T_t , and the tax τ_t^c as given. The first order conditions with respect to C_t and K_t are

$$\beta^t \zeta_t \varphi_t C_t^{-\sigma} = \lambda_t (1 + \tau_t^c), \quad \lambda_t = \lambda_{t+1} (1 + r_{t+1}), \quad (\text{C.12})$$

which combine into the **aggregate Euler equation**

$$\boxed{1 + r_{t+1} = \frac{1}{\beta} \frac{\zeta_t}{\zeta_{t+1}} \frac{\varphi_t}{\varphi_{t+1}} \left(\frac{C_{t+1}}{C_t} \right)^\sigma \frac{1 + \tau_{t+1}^c}{1 + \tau_t^c}} \quad (\text{C.13})$$

Using $\varphi_t = N_t^\sigma$ from (C.9) and defining the gross growth rates $N_{t+1}^g \equiv N_{t+1}/N_t$ and $\zeta_{t+1}^g \equiv \zeta_{t+1}/\zeta_t$,

$$1 + r_{t+1} = \frac{1}{\beta \zeta_{t+1}^g (N_{t+1}^g)^\sigma} \left(\frac{C_{t+1}}{C_t} \right)^\sigma \frac{1 + \tau_{t+1}^c}{1 + \tau_t^c}. \quad (\text{C.14})$$

With $\zeta_{t+1}^g = 1$, Equation (C.14) is the individual Euler equation (C.4) evaluated at consumption per person, which equal weights make common to all ages. The survival shifter ζ_{t+1}^g is the only term that does not come from the individual conditions. Consumption growth per person enters with elasticity σ , and the consumption tax wedge affects saving. This is the analogue with one production sector and consumption tax financing of the aggregate representation in Papetti (2019).

D Characterization of the equilibrium

This appendix derives the compact system that characterizes the equilibrium in Section B. As in Papetti (2019), we set $A_t = A = 1$ to isolate the demographic mechanism. Because production has one sector, there is no labor allocation share to determine and consumption dynamics appear directly.

D.a Factor prices in efficiency units

Define capital and other quantities per efficiency unit of labor: $\tilde{K}_{t-1} \equiv K_{t-1}/L_t$, $\tilde{Y}_t \equiv Y_t/L_t$, $\tilde{C}_t \equiv C_t/L_t$, and $L_{t+1}^g \equiv L_{t+1}/L_t$. With $A = 1$, the production function (8) becomes

$$\tilde{Y}_t = \frac{Y_t}{L_t} = \left(\frac{K_{t-1}}{L_t} \right)^\psi = \tilde{K}_{t-1}^\psi. \quad (\text{D.1})$$

The firm's first order conditions in Equations (10) and (11) give

$$r_t + \delta = \psi \tilde{K}_{t-1}^{\psi-1} \implies \tilde{K}_{t-1} = \left(\frac{\psi}{r_t + \delta} \right)^{\frac{1}{1-\psi}}, \quad (\text{D.2})$$

$$w_t = (1 - \psi) \tilde{K}_{t-1}^\psi = (1 - \psi) \left(\frac{\psi}{r_t + \delta} \right)^{\frac{\psi}{1-\psi}}. \quad (\text{D.3})$$

Equations (D.2) and (D.3) give the standard inverse relationships between the real interest rate, capital per efficiency unit of labor, and the real wage. They are identical to those in the baseline model.

D.b Consumption from the resource constraint

Divide the resource constraint (12) by L_t . Using $K_t/L_t = (K_t/L_{t+1})(L_{t+1}/L_t) = \tilde{K}_t L_{t+1}^g$ and (D.1),

$$\tilde{C}_t = \tilde{K}_{t-1}^\psi + (1 - \delta) \tilde{K}_{t-1} - L_{t+1}^g \tilde{K}_t. \quad (\text{D.4})$$

Equivalently, investment in efficiency units is $\tilde{I}_t = L_{t+1}^g \tilde{K}_t - (1 - \delta) \tilde{K}_{t-1}$ and $\tilde{C}_t = \tilde{Y}_t - \tilde{I}_t$.

D.c The Euler equation in efficiency units

Write the aggregate Euler equation (C.14) in efficiency units. Since $C_t = \tilde{C}_t L_t$, consumption growth is $C_{t+1}/C_t = (\tilde{C}_{t+1}/\tilde{C}_t) L_{t+1}^g$, so

$$1 + r_{t+1} = \frac{(L_{t+1}^g)^\sigma}{\beta \zeta_{t+1}^g (N_{t+1}^g)^\sigma} \left(\frac{\tilde{C}_{t+1}}{\tilde{C}_t} \right)^\sigma \frac{1 + \tau_{t+1}^c}{1 + \tau_t^c}. \quad (\text{D.5})$$

i.e. the new tax wedge $(1 + \tau_{t+1}^c)/(1 + \tau_t^c)$ is the channel through which pension financing affects the natural interest rate.

D.d The consumption tax rate

From the government budget (B.38), with $C_t = \tilde{C}_t L_t$ and the retired population $N_t^{\text{ret}} \equiv \sum_{j=j_r+1}^J N_{t,j}$,

$$\tau_t^c = \frac{\bar{d} w_t \bar{h} N_t^{\text{ret}}}{\tilde{C}_t L_t} = \bar{d} \bar{h} \frac{w_t}{\tilde{C}_t} \Omega_t, \quad (\text{D.6})$$

where Ω_t is the effective old age dependency ratio defined in (23). It differs from the standard dependency ratio because the denominator is labor measured in efficiency units rather than the number of working age people.

D.e The system

Collecting (D.2), (D.3), (D.4), (D.5) and (D.6), the equilibrium is fully characterized by five equations in the five endogenous variables $\{w_t, r_t, \tilde{K}_t, \tilde{C}_t, \tau_t^c\}$:

$$w_t = (1 - \psi) \left(\frac{\psi}{r_t + \delta} \right)^{\frac{\psi}{1-\psi}} \quad (\text{D.7})$$

$$\tilde{K}_{t-1} = \left(\frac{\psi}{r_t + \delta} \right)^{\frac{1}{1-\psi}} \quad (\text{D.8})$$

$$\tilde{C}_t = \tilde{K}_{t-1}^\psi + (1 - \delta) \tilde{K}_{t-1} - L_{t+1}^g \tilde{K}_t \quad (\text{D.9})$$

$$1 + r_{t+1} = \frac{(L_{t+1}^g)^\sigma}{\beta \zeta_{t+1}^g (N_{t+1}^g)^\sigma} \left(\frac{\tilde{C}_{t+1}}{\tilde{C}_t} \right)^\sigma \frac{1 + \tau_{t+1}^c}{1 + \tau_t^c} \quad (\text{D.10})$$

$$\tau_t^c = \bar{d} \bar{h} \frac{w_t}{\tilde{C}_t} \Omega_t \quad (\text{D.11})$$

given the exogenous paths of L_{t+1}^g , N_{t+1}^g , ζ_{t+1}^g and Ω_t .

D.f Boundary conditions and solution

The model is solved over a finite horizon $t = 0, 1, \dots, T$ with a shooting algorithm. The economy is assumed to be in a steady state with no population growth before 1950 and to return to that steady state after 2100. The boundary conditions are

$$r_0 = r_{ss} = \frac{1}{\beta} - 1, \quad r_T = r_{ss}, \quad (\text{D.12})$$

or equivalently in terms of the capital ratio:

$$\tilde{K}_{-1} = \tilde{K}_{ss} = \left(\frac{\psi}{r_{ss} + \delta} \right)^{\frac{1}{1-\psi}}, \quad \tilde{K}_T = \tilde{K}_{ss}. \quad (\text{D.13})$$

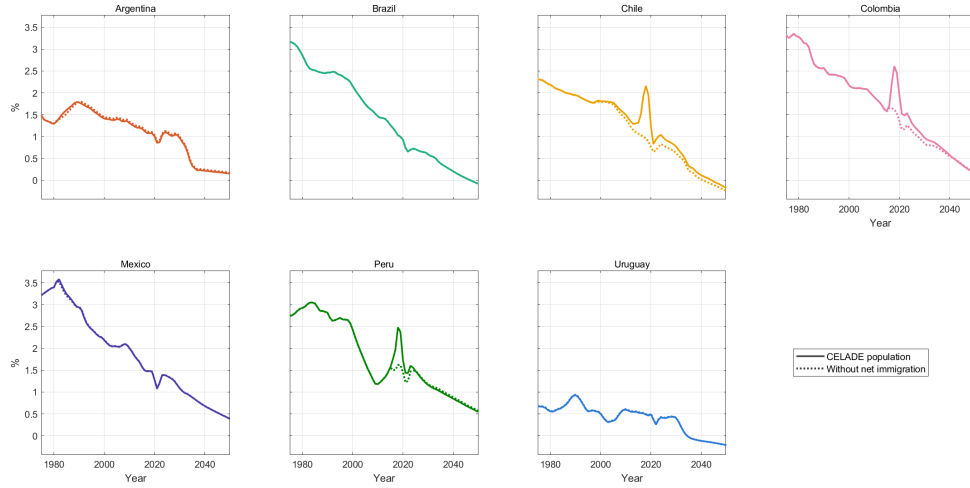
The algorithm starts from a guess for r_t , or equivalently $\tilde{K}_t$, solves forward with the resource constraint and backward with the Euler equation, and updates the path until convergence. The version with consumption tax financing adds an equation for τ_t^c but requires no additional boundary condition because the government budget determines the tax in every period.

E Robustness to immigration

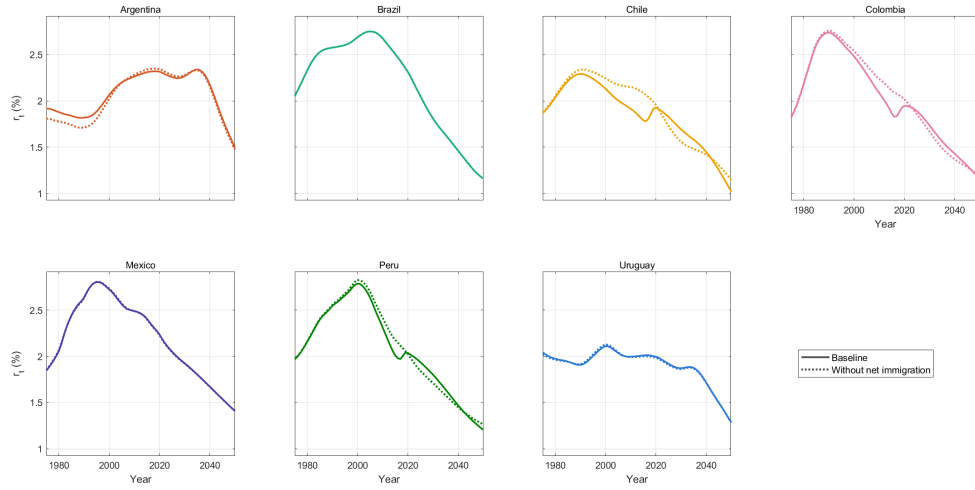
The population data include net migration. Because conditional survival is inferred from the ratio of consecutive cohort sizes, $s_{t,j} = N_{t,j}/N_{t-1,j-1}$, net immigration raises the implied survival probabilities and can push them above one. Immigration therefore affects the survival shifter ζ_t^g as well as N_t^g and L_t^g , and under perfect foresight households anticipate migration episodes such as the inflow from Venezuela into Chile, Colombia, and Peru around 2018 and 2019.

To assess the role of these inflows, we construct a population that puts a limit on the immigration effect. Whenever the implied survival probability at a given age exceeds one, we replace it with its value for the same age in the previous year, and we rebuild each cohort recursively, $\hat{N}_{t,j} = \hat{N}_{t-1,j-1} \hat{s}_{t,j}$. We then recompute N_t^g , L_t^g , and ζ_t^g and solve the baseline model with these inputs. Because it only corrects implied survival probabilities above one, the adjustment removes net immigration where it exceeds mortality, mainly at working ages, and leaves net emigration unchanged.

Figure E.1.a shows that the adjustment removes the temporary increase in population growth around 2018 and 2019 in Chile, Colombia, and Peru. Figure E.1.b compares the equilibrium rates. Without net immigration, the decline before 2020 and the subsequent rebound disappear, so the paths become smoother. Rates before the migration episode are up to about 0.3 percentage points higher in Chile and Colombia, and rates between the mid 2020s and the early 2040s are somewhat lower. In the other countries, the differences are below 0.2 percentage points. From each country's peak to 2050, the equilibrium rate falls by 0.85 to 1.59 percentage points, compared with 0.83 to 1.59 in the baseline, and the timing of the sustained decline is unchanged. Immigration therefore shapes the dynamics around the migration episode but does not drive the main results.



(a)



(b)

Figure E.1: Population growth and equilibrium real rates without net immigration. Notes: Panel (a) reports annual growth of the population aged 14 to 99; panel (b) reports the equilibrium real rate of the baseline model. Solid lines use the CELADE population; dotted lines use the population rebuilt without net immigration inflows. Source: Authors' calculations using CELADE Population Division of ECLAC and United Nations, 2024 Revision.