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## **RCESR Discussion Paper Series**

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Transitions, and the Shifting Phillips Curve

March 2026

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# Aging and the Price Level: Irreversible Capital, Demographic Transitions, and the Shifting Phillips Curve

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This Draft: March 26, 2026

**Abstract.** Why have the world’s most rapidly aging economies experienced decades of low inflation followed by emerging supply-side price pressures? We propose a mechanism based on the interaction between demographic change and the irreversibility of physical capital. In a three-generation overlapping-generations model with Calvo pricing and irreversible investment ( $I_t \geq 0$ ), durable capital built during the demographic bonus period cannot be rapidly scrapped when population declines, creating a prolonged overhang of productive capacity relative to demand. As depreciation gradually erodes this overhang and the labor force continues to shrink, the economy eventually transitions from structural excess supply to a supply-constrained regime. Reduced-form evidence from 38 economies over 1965–2019 is consistent with the model’s predictions: aging is associated with lower inflation, the Phillips curve slope declines with the elderly share, and countries that experienced migration-driven population reversals exhibit more stable slopes—patterns that the irreversibility mechanism can account for. We interpret the negative Phillips curve slope estimated for Japan after 2015 as suggestive of the onset of the supply-constrained phase, though causal identification remains an important limitation of the international panel design.

**Keywords:** population aging; inflation; irreversible investment; overlapping generations; supply constraints; international panel data

**JEL Codes:** E22, E31, E52, J11, O41

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*Acknowledgements.* This research was supported by the Japan Society for the Promotion of Science (JSPS KAKENHI Grants 24H00012 and 20H00082).

# 1 Introduction

Since the 1990s, the world’s most rapidly aging economies have exhibited persistently low inflation that defied conventional Phillips curve logic. More recently, a subset of these same economies—Japan most prominently—has begun to experience inflation driven not by excess demand but by labor shortages and production bottlenecks. This paper proposes a mechanism that can account for both phenomena: the *interaction between demographic change and the irreversibility of physical capital*.

The mechanism operates as follows. When the working-age population shrinks, aggregate demand falls. But the supply side cannot adjust symmetrically: productive capital built during the demographic bonus period is durable and cannot be costlessly scrapped. The irreversibility of investment ( $I_t \geq 0$ ) means that the capital stock declines only at the rate of physical depreciation. The resulting overhang of productive capacity generates structural excess supply, deflationary pressure, and the appearance of a flattened Phillips curve. As depreciation gradually erodes this overhang and the labor force continues to shrink, the economy may eventually transition to a supply-constrained regime in which potential output falls below demand.

We formalize this mechanism in a three-generation overlapping-generations model with Calvo pricing and irreversible capital accumulation. The model delivers three core predictions:

1. The relationship between aging and inflation is *phase-dependent*: deflationary during the capital-overhang period, potentially inflationary thereafter (Propositions 1 and 3).
2. The Phillips curve slope declines endogenously with aging, through both composition and level effects (Proposition 2).
3. Migration-driven labor supply recovery can reverse the phase dynamics, providing within-model variation for informal identification (Proposition 5).

We evaluate these predictions against reduced-form evidence from 38 economies spanning 1965–2019, using two-way fixed effects, system GMM (Blundell and Bond, 1998), and the DCCEMG estimator of Chudik and Pesaran (2015). The patterns in the data are broadly consistent with the model: the elderly-share coefficient is significantly negative (Table 2), the Phillips curve slope

declines with the elderly share (Table 4), and countries that experienced migration-driven population reversals exhibit more stable slopes (Figure 3).

**Identification caveat.** We emphasize that the international panel estimates establish *associations consistent with the model* rather than definitive causal effects. Aging is correlated with institutional change, globalization, technology adoption, and fiscal evolution, and the two-way fixed effects and GMM instruments used here cannot fully rule out confounding by these slow-moving forces. We view the reduced-form evidence as disciplining the theoretical framework rather than as stand-alone causal identification. The Type III countries (Section 6) provide the closest approximation to a natural experiment, but a fully identified design using, for example, cohort-based shift-share instruments or subnational panels with policy-induced demographic variation, remains an important direction for future work.

**Related literature.** This paper contributes to three literatures.

*Demographics and inflation.* Juselius and Takats (2021) document that age structure predicts inflation in a 22-country panel; Aksoy et al. (2019) use a structural VAR but impose linearity; Yoon et al. (2018) and Liu and Westelius (2017) study Japan-specific effects. Our contribution is the structural model—irreversible capital interacting with demographic decline—that explains why the relationship is nonlinear and phase-dependent.

*OLG macroeconomics.* Fujiwara and Teranishi (2011) develop an OLG-NK model focusing on the natural rate; Eggertsson et al. (2019) build a secular stagnation model. We extend this literature by introducing supply-side irreversibility, which generates the asymmetric adjustment that standard OLG models cannot produce: without irreversibility, aging is monotonically deflationary.

*Irreversible investment.* The irreversibility constraint has been studied extensively in the real options literature (Dixit and Pindyck, 1994). We embed this mechanism in a macroeconomic model of inflation dynamics. Goodhart and Pradhan (2020) argue informally that the “Great Demographic Reversal” will bring inflation back; our model provides formal conditions under which this may occur.

The paper proceeds as follows. Section 2 presents the model. Section 3 derives the propositions. Section 4 describes the empirical strategy. Section 5 presents the data and estimation results. Section 6 provides the structural interpretation, including a multi-country calibration. Section 7 concludes.

## 2 Model

We develop a three-generation overlapping-generations model with irreversible capital accumulation and New Keynesian price rigidity. The model is deliberately parsimonious: it contains the minimum structure necessary to generate the three-phase dynamics documented in the empirical sections, while remaining analytically tractable. A full dynamic stochastic general equilibrium extension with numerical transition dynamics is reserved for companion work.

The economy consists of three blocks: households, firms, and a central bank. A demographic transition, modeled as an exogenous population process, drives the dynamics.

### 2.1 Demographics

**Assumption 1** (Exogenous population structure). *At each date  $t$ , the population consists of three generations: young ( $Y$ , ages 0–14), working-age ( $W$ , ages 15–64), and old ( $O$ , ages 65+), with sizes  $n_t^Y, n_t^W, n_t^O > 0$ . The total population is  $N_t \equiv n_t^Y + n_t^W + n_t^O$ . The generational transition satisfies*

$$n_{t+1}^W = \phi_t n_t^Y, \quad n_{t+1}^O = \psi n_t^W, \quad (1)$$

where  $\psi \in (0, 1]$  is the (constant) working-to-old survival rate and  $\phi_t \in (0, 1]$  is the (possibly time-varying) youth-to-working transition rate that captures fertility and immigration.<sup>1</sup>

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<sup>1</sup>The distinction between  $\phi_t$  and  $\psi$  is important:  $\psi$  is approximately constant in the postwar period for advanced economies, while  $\phi_t$  declines secularly with falling fertility and can jump with migration shocks (Type III countries).

Define the *elderly dependency ratio*

$$\omega_t \equiv \frac{n_t^O}{n_t^W}, \quad (2)$$

and the *effective labor supply*

$$L_t \equiv n_t^Y \ell^Y + n_t^W \ell^W, \quad (3)$$

where  $\ell^Y < \ell^W$  are generation-specific labor endowments (the young participate at lower rates due to education). The labor supply peaks when the large cohorts born during the “baby boom” are of working age, and declines thereafter.

**Definition 1** (Demographic bonus and onus). *The economy is in the demographic bonus period if  $\Delta L_t \equiv L_t - L_{t-1} > 0$  (growing labor supply), and in the demographic onus period if  $\Delta L_t < 0$  (shrinking labor supply).*

## 2.2 Households

The working-age generation  $W$  is the sole decision-making cohort. A representative worker born into generation  $W$  at date  $t$  lives for two decision periods: working age ( $t$ ) and old age ( $t + 1$ ). The worker supplies labor inelastically at the market wage  $w_t$ , consumes  $C_t^W$ , and saves  $S_t$ . In old age, the worker consumes  $C_{t+1}^O$  from accumulated savings plus a public transfer  $\tau_{t+1}$  (pension, representing dissaving).<sup>2</sup>

$$\max_{C_t^W, C_{t+1}^O} u(C_t^W) + \beta u(C_{t+1}^O) \quad \text{s.t.} \quad C_t^W + S_t = w_t \ell^W, \quad C_{t+1}^O = (1 + r_t)S_t + \tau_{t+1}, \quad (4)$$

where  $u(C) = C^{1-\sigma}/(1-\sigma)$  with  $\sigma > 0$ ,  $\beta \in (0, 1)$  is the subjective discount factor, and  $r_t$  is the real interest rate.

The Euler equation is

$$u'(C_t^W) = \beta(1 + r_t)u'(C_{t+1}^O). \quad (5)$$

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<sup>2</sup>The young generation  $Y$  is non-optimizing; its consumption is financed by intrahousehold transfers. This simplification is standard in the OLG-New Keynesian literature (Fujiwara and Teranishi, 2011).

**Aggregate demand.** Total consumption demand at date  $t$  is the sum of demands across all living generations:

$$Y_t^d = n_t^Y c^Y + n_t^W C_t^{W*} + n_t^O C_t^{O*} + G_t, \quad (6)$$

where  $c^Y$  is exogenous per-capita youth consumption,  $C_t^{W*}$  and  $C_t^{O*}$  are the optimal consumption levels from (4), and  $G_t$  is government expenditure. The critical feature of (6) is that the *composition* of the population matters: a shift from  $n_t^Y$  (high per-capita housing and durable demand) to  $n_t^O$  (low per-capita marginal demand) reduces aggregate demand even if  $N_t$  is unchanged.

**Remark 1** (Demand demographics). *Define the demographic demand index*

$$D_t \equiv \frac{n_t^Y c^Y + n_t^W c^W + n_t^O c^O}{N_0 \bar{c}_0}, \quad (7)$$

where  $\bar{c}_0$  is the population-weighted average consumption at  $t = 0$ . The index  $D_t$  captures the age-composition effect on aggregate demand, normalized to unity in the initial period. In our calibration,  $c^Y/c^W = 1.15$  and  $c^O/c^W = 0.75$ , reflecting the high marginal propensity to consume housing and durables among young households and the low marginal propensity among the elderly.

## 2.3 Firms

**Assumption 2** (Technology and irreversibility). *A representative firm produces output using capital  $K_t$  and labor  $L_t^d$  with a constant-returns-to-scale production function:*

$$Y_t^* = A K_t^\alpha (L_t^d)^{1-\alpha}, \quad \alpha \in (0, 1), \quad (8)$$

where  $A > 0$  is total factor productivity.<sup>3</sup>

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<sup>3</sup>The use of Cobb–Douglas is for analytical tractability. Diewert, Nomura, and Shimizu (2025) show that the CES restriction is rejected for Japan, and our companion work extends the analysis using the Normalized Quadratic functional form. The qualitative results of the present model—in particular, the phase structure and the direction of all comparative statics—hold for any concave, homogeneous-of-degree-one production function  $F(K, L)$ .

Capital accumulates according to

$$K_{t+1} = (1 - \delta)K_t + I_t, \quad \delta \in (0, 1), \quad (9)$$

subject to the *irreversibility constraint*

$$I_t \geq 0. \quad (10)$$

**Remark 2** (Economic interpretation of irreversibility). *Constraint (10) is the core assumption that generates the asymmetric supply–demand dynamics. Factories, commercial buildings, and infrastructure built during the demographic bonus period are durable and cannot be costlessly dismantled when population declines. Firms continue operating with excess capacity rather than incurring scrapping costs. The constraint does not require that disinvestment is literally impossible—only that it is costly enough to make  $I_t = 0$  the optimal choice when the desired capital stock falls below the current stock.*<sup>4</sup>

**Optimal investment.** The firm’s investment problem is to choose  $\{I_t\}$  to maximize

$$\sum_{s=0}^{\infty} \Lambda_{t,t+s} \left[ A K_{t+s}^{\alpha} (L_{t+s}^d)^{1-\alpha} - w_{t+s} L_{t+s}^d - I_{t+s} \right] \quad (11)$$

subject to (9) and (10), where  $\Lambda_{t,t+s}$  is the stochastic discount factor. In labor market equilibrium,  $L_t^d = L_t$  (labor supply equals demand).

The first-order condition yields

$$q_t = 1 + \mu_t, \quad (12)$$

where  $q_t$  is Tobin’s  $q$  (the shadow value of installed capital) and  $\mu_t \geq 0$  is the multiplier on the irreversibility constraint (10). By complementary slackness:

$$\mu_t \geq 0, \quad I_t \geq 0, \quad \mu_t \cdot I_t = 0. \quad (13)$$

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<sup>4</sup>Formally, one could model adjustment costs that are asymmetric:  $\Phi(I_t, K_t) = (\xi/2)(I_t/K_t)^2 K_t$  for  $I_t \geq 0$  and  $\Phi(I_t, K_t) = +\infty$  for  $I_t < 0$ . The irreversibility constraint (10) is the limiting case  $\xi \rightarrow 0$  for positive investment and infinite cost for negative investment.

**Desired capital stock.** In the absence of the irreversibility constraint, the firm's desired capital stock satisfies the standard condition:

$$K_t^* = \left( \frac{\alpha A}{r + \delta} \right)^{1/(1-\alpha)} L_t, \quad (14)$$

where  $r$  is the user cost of capital. When  $K_t^* < (1 - \delta)K_{t-1}$  (i.e., the desired stock is below the depreciated existing stock), the irreversibility constraint binds ( $I_t = 0, \mu_t > 0$ ), and the actual capital stock exceeds the desired level:

$$K_t = (1 - \delta)K_{t-1} > K_t^*. \quad (15)$$

**Potential output dynamics under irreversibility.** Potential output  $Y_t^* = AK_t^\alpha L_t^{1-\alpha}$  evolves differently depending on whether the irreversibility constraint binds.

*Case 1:  $I_t > 0$  (unconstrained).* Capital adjusts to  $K_t^*$ , and potential output tracks the efficient level:

$$Y_t^{*,unc} = A \left( \frac{\alpha A}{r + \delta} \right)^{\alpha/(1-\alpha)} L_t. \quad (16)$$

Potential output is proportional to  $L_t$  and moves in lockstep with labor supply.

*Case 2:  $I_t = 0$  (constrained).* Capital depreciates passively:  $K_t = (1 - \delta)^s K_{t_0}$ , where  $t_0$  is the date at which the constraint first binds. The growth rate of potential output is

$$\frac{\dot{Y}_t^*}{Y_t^*} = \alpha \cdot (-\delta) + (1 - \alpha) \cdot \frac{\dot{L}_t}{L_t} = -\alpha\delta + (1 - \alpha)g_L, \quad (17)$$

where  $g_L \equiv \dot{L}_t/L_t < 0$  during the onus period. The key observation is that  $Y_t^*$  declines at rate  $\alpha\delta + (1 - \alpha)|g_L|$ , which is *slower* than the decline in the unconstrained case  $Y_t^{*,unc}$  (which falls proportionally to  $L_t$ ). This is because excess capital continues to produce output even though it is no longer desired. The gap between  $Y_t^*$  and  $Y_t^{*,unc}$  represents the *supply-side irreversibility overhang*.

## 2.4 Price Setting and the Phillips Curve

**Assumption 3** (Calvo pricing). *A fraction  $1 - \theta$  of firms reset prices each period, with  $\theta \in (0, 1)$ .*

*The resulting New Keynesian Phillips Curve is*

$$\pi_t = \beta \mathbb{E}_t[\pi_{t+1}] + \kappa \tilde{y}_t, \quad (18)$$

where  $\pi_t$  is the inflation rate,  $\tilde{y}_t \equiv \ln(Y_t^d/Y_t^*)$  is the output gap (log ratio of aggregate demand to potential output), and  $\kappa \equiv (1 - \theta)(1 - \beta\theta)/\theta > 0$ .

We augment the standard NKPC with a direct demographic effect:

$$\pi_t = \beta \mathbb{E}_t[\pi_{t+1}] + \kappa \tilde{y}_t + \gamma \omega_t, \quad (19)$$

where  $\omega_t = n_t^O/n_t^W$  is the elderly dependency ratio and  $\gamma < 0$  captures the political economy channel: a larger elderly population shifts the median voter's inflation preference downward (Bullard, Garriga, and Waller, 2012), reducing the effective inflation target.

**Remark 3** (The output gap is endogenous to demographics). *The critical feature of the model is that  $\tilde{y}_t$  in (19) is itself a function of the demographic variables, through both the numerator ( $Y_t^d$  depends on  $D_t$ ) and the denominator ( $Y_t^*$  depends on  $L_t$  and on the irreversibility constraint). The total effect of demographics on inflation is therefore*

$$\frac{d\pi_t}{d\omega_t} = \kappa \frac{\partial \tilde{y}_t}{\partial \omega_t} + \gamma, \quad (20)$$

where the first term captures the indirect effect through the output gap and the second term captures the direct political economy effect. The sign of  $\partial \tilde{y}_t / \partial \omega_t$  changes across phases, generating the nonlinearity that is the paper's central contribution.

## 2.5 Monetary Policy

The central bank sets the nominal interest rate according to a Taylor rule:

$$i_t = r_t^* + \phi_\pi(\pi_t - \pi^*) + \phi_y \tilde{y}_t, \quad \phi_\pi > 1, \phi_y > 0, \quad (21)$$

where  $r_t^*$  is the natural rate of interest and  $\pi^*$  is the inflation target.

## 2.6 Equilibrium

**Definition 2** (Equilibrium). *A competitive equilibrium is a sequence  $\{C_t^W, C_t^O, S_t, K_t, I_t, L_t^d, w_t, r_t, \pi_t, i_t, Y_t^*, Y_t^d\}_{t=0}^\infty$  such that: (i) households solve (4) given prices; (ii) firms solve (11) subject to (9)–(10); (iii) the labor market clears ( $L_t^d = L_t$ ); (iv) the goods market clears ( $Y_t = \min\{Y_t^*, Y_t^d\}$ ); (v) the NKPC (19) holds; and (vi) monetary policy follows (21).*

# 3 Theoretical Predictions

We now derive the model's key predictions. Each proposition corresponds to a specific empirical finding in Section 6.

## 3.1 Phase Classification

The output gap  $\tilde{y}_t = \ln(Y_t^d/Y_t^*)$  is determined by the interaction of aggregate demand  $Y_t^d$  (driven by the demographic demand index  $D_t$ ) and potential output  $Y_t^*$  (driven by  $K_t$  and  $L_t$ , with  $K_t$  subject to irreversibility). We define three phases based on the sign and dynamics of  $\tilde{y}_t$ .

**Definition 3** (Three phases).

- (i) **Phase 1 (Bonus):**  $L_t$  is rising,  $I_t > 0$ ,  $K_t \approx K_t^*$ ,  $\tilde{y}_t \approx 0$ . *Balanced growth with moderate inflation.*
- (ii) **Phase 2 (Early Onus):**  $L_t$  is falling,  $I_t = 0$  binds,  $K_t > K_t^*$ ,  $\tilde{y}_t < 0$ . *Structural excess supply, deflationary pressure.*

(iii) **Phase 3 (Late Onus):**  $L_t$  continues to fall,  $K_t$  has depreciated sufficiently that  $Y_t^* < Y_t^d$ ,  $\tilde{y}_t > 0$ .

*Supply-constrained inflation.*

### 3.2 Proposition 1: Persistence of Excess Supply in Phase 2

**Proposition 1** (Phase 2 duration). *Suppose the economy enters Phase 2 at date  $t_0$  (i.e.,  $I_{t_0} = 0$  binds for the first time). Let  $Y_{t_0}^d/Y_{t_0}^* = \exp(\tilde{y}_{t_0}) < 1$ . The excess supply regime persists for at least*

$$T_2 \geq \frac{1}{\delta} \ln \left( \frac{K_{t_0}}{K_{t_0}^*} \right) \quad (22)$$

*periods, where  $K_{t_0}^*$  is the desired capital stock at  $t_0$ . The output gap  $\tilde{y}_t$  remains negative throughout Phase 2, and the equilibrium inflation rate satisfies  $\pi_t < \pi^*$ .*

*Proof.* When  $I_t = 0$  for  $t \geq t_0$ , capital evolves as  $K_t = (1 - \delta)^{t-t_0} K_{t_0}$ . The gap between actual and desired capital is  $K_t - K_t^* = (1 - \delta)^{t-t_0} K_{t_0} - K_t^*$ . Since  $K_t^*$  is proportional to  $L_t$  (equation 14) and  $L_t$  is declining,  $K_t^*$  also declines. The excess capital  $K_t - K_t^*$  closes at the rate  $\delta$  (depreciation) minus the rate of decline of  $K_t^*$ . The minimum duration  $T_2$  obtains when  $K_t$  catches down to  $K_t^*$ , requiring  $(1 - \delta)^{T_2} K_{t_0} = K_{t_0}^*$ , which yields (22).

During Phase 2,  $Y_t^* = AK_t^\alpha L_t^{1-\alpha} > Y_t^d$  (because  $K_t > K_t^*$  implies  $Y_t^*$  exceeds the demand-consistent output level). Hence  $\tilde{y}_t < 0$ , and the NKPC (19) delivers  $\pi_t < \beta \mathbb{E}_t[\pi_{t+1}] + \gamma \omega_t < \pi^*$  when  $\gamma < 0$  and  $\omega_t$  is rising. ■

**Empirical correspondence.** Tables 2 and 3 report  $\hat{\alpha}_{old} < 0$  (significantly negative elderly coefficient): a rising elderly share is associated with lower inflation. Proposition 1 provides the structural interpretation: the negative coefficient reflects the dominance of Phase 2 dynamics in the sample period (1965–2019), during which most aging economies experienced structural excess supply.

**Calibration.** For Japan,  $\delta = 0.06$  and the capital overhang at the onset of Phase 2 (circa 1995) is approximately  $K_{t_0}/K_{t_0}^* \approx 1.15$ . Equation (22) yields  $T_2 \geq (1/0.06) \ln(1.15) \approx 2.3$  years as a *lower*

bound; the actual duration is much longer because  $L_t$  continues to decline, keeping  $K_t^*$  below  $K_t$  for approximately 20 years—consistent with Japan’s deflation from the mid-1990s to the mid-2010s.

### 3.3 Proposition 2: Phillips Curve Flattening

**Proposition 2** (Apparent flattening). *In Phase 2, the observed sensitivity of inflation to the output gap—the “slope” of the Phillips curve—is lower than in Phase 1. This flattening arises from two mechanisms:*

- (a) **Composition effect:** *The economy operates chronically in the region  $\tilde{y}_t < 0$ . If nominal wages exhibit downward rigidity, the mapping from  $\tilde{y}_t$  to  $\pi_t$  is concave (flatter for  $\tilde{y}_t < 0$  than for  $\tilde{y}_t > 0$ ), so that the observed slope  $\partial\pi_t/\partial\tilde{y}_t$  is attenuated.*
- (b) **Level effect:** *The direct demographic term  $\gamma\omega_t$  with  $\gamma < 0$  shifts the NKPC downward as  $\omega_t$  rises, reducing the intercept and hence the average inflation conditional on any given gap.*

*Proof.* (a) Augment the NKPC with an asymmetric Phillips curve:  $\pi_t = \beta\mathbb{E}_t[\pi_{t+1}] + \kappa^+ \max(0, \tilde{y}_t) + \kappa^- \min(0, \tilde{y}_t) + \gamma\omega_t$ , where  $\kappa^+ > \kappa^-$  captures downward nominal rigidity. In Phase 2,  $\tilde{y}_t < 0$  for all  $t$ , so the effective slope is  $\kappa^-$ , which is smaller than the Phase 1 slope  $\kappa^+$ .

(b) In the linear NKPC (19), a regression of  $\pi_t$  on  $\tilde{y}_t$  with omitted  $\omega_t$  yields a biased slope estimate. If  $\text{Cov}(\tilde{y}_t, \omega_t) < 0$  (as it is in Phase 2, where a higher  $\omega_t$  is associated with a more negative  $\tilde{y}_t$ ), the omission of  $\omega_t$  with  $\gamma < 0$  biases the estimated slope toward zero. ■

**Empirical correspondence.** Table 5 reports  $\hat{\delta}_{old} < 0$ : an interaction between the elderly share and the output gap with a significantly negative coefficient. In the notation of our model, the estimated equation (17) is

$$\pi_{it} = \dots + (\beta_3 + \delta_{old} \Delta\omega_{it}) \hat{y}_{it} + \dots \quad (23)$$

Proposition 2 predicts  $\delta_{old} < 0$ : as  $\omega_{it}$  rises (Phase 2 deepens), the effective Phillips curve slope  $\beta_3 + \delta_{old} \Delta\omega_{it}$  declines. The estimate  $\hat{\delta}_{old} = -3.674$  (Table 5, sample JT) is the *reduced-form* expression of the joint operation of the composition and level effects.

### 3.4 Proposition 3: Delayed but Eventual Supply Constraint

**Proposition 3** (Existence of Phase 3 transition). *Suppose  $\eta > 1 - \alpha$  (the demand elasticity with respect to labor exceeds the labor share in output). Then under irreversibility ( $I_t = 0$ ), the output gap  $\tilde{y}_t$  monotonically increases over time: the capital overhang is eroded by depreciation faster than demand declines. Eventually,  $\tilde{y}_t$  crosses zero and the economy enters the supply-constrained regime (Phase 3).*

**Proposition 4** (Speed of transition). *Define  $\lambda_t \equiv -\dot{L}_t/L_t > 0$  and*

$$\bar{\lambda} = \frac{\alpha\delta}{\eta - (1 - \alpha)}. \quad (24)$$

*For  $\lambda_t \in (0, \bar{\lambda})$ , the gap between demand and supply growth rates satisfies  $g_{Y^d} - g_{Y^*} > 0$ , so the overhang erodes. The transition is faster when  $\lambda_t$  is larger,  $\delta$  is higher, or  $\alpha$  is higher.*

*Proof.* In Phase 2,  $I_t = 0$  and  $K_t = (1 - \delta)^s K_{t_0}$ . The growth rates of potential output and aggregate demand are

$$g_{Y^*} = \alpha(-\delta) + (1 - \alpha)(-\lambda_t) = -\alpha\delta - (1 - \alpha)\lambda_t, \quad (25)$$

$$g_{Y^d} = -\eta\lambda_t. \quad (26)$$

The output gap  $\tilde{y}_t = \ln(Y_t^d/Y_t^*)$  widens (becomes less negative) when  $g_{Y^d} > g_{Y^*}$ , i.e., when demand declines *more slowly* than potential output:

$$-\eta\lambda_t > -\alpha\delta - (1 - \alpha)\lambda_t \quad \Leftrightarrow \quad (1 - \alpha - \eta)\lambda_t > -\alpha\delta.$$

When  $\eta > 1 - \alpha$  (i.e., the demand elasticity exceeds the labor share in output—empirically,  $\eta = 0.85 > 0.65 = 1 - \alpha$  in the Japan calibration), we have  $1 - \alpha - \eta < 0$ , and dividing by the negative

coefficient reverses the inequality:

$$\lambda_t < \frac{\alpha\delta}{\eta - (1 - \alpha)} \equiv \bar{\lambda}.$$

Since  $\lambda_t > 0$  and  $\bar{\lambda} > 0$ , this condition is satisfied for all  $\lambda_t \in (0, \bar{\lambda})$ . Economically: even a moderate rate of labor-force decline suffices to trigger Phase 3, because the capital depreciation term  $-\alpha\delta$  in  $g_{Y^*}$  ensures that supply declines faster than demand as long as the irreversibility constraint binds. The economy enters Phase 3 not because labor decline accelerates past a threshold, but because the *cumulative* capital depreciation under  $I_t = 0$  eventually erodes the supply overhang. The higher  $\delta$  is, the faster the overhang erodes and the sooner Phase 3 arrives. ■

**Comparative statics of  $\bar{\lambda}$ .** Equation (24) yields two implications:

- (i)  $\partial\bar{\lambda}/\partial\alpha > 0$ : capital-intensive economies have a wider range of labor-decline rates compatible with Phase 3 transition, because higher  $\alpha$  amplifies the capital depreciation channel in  $g_{Y^*}$ .
- (ii)  $\partial\bar{\lambda}/\partial\delta > 0$ : economies with faster depreciation (e.g., ICT-intensive) erode the capital overhang more quickly, widening the conditions for Phase 3.

**Calibration.** For Japan ( $\alpha = 0.35$ ,  $\delta = 0.06$ ,  $\eta = 0.85$ ):

$$\bar{\lambda} = \frac{0.35 \times 0.06}{0.85 - 0.65} = \frac{0.021}{0.20} = 0.105.$$

Japan's annual working-age population decline rate has been approximately 0.7–1.0% since 2000, well within the range  $(0, \bar{\lambda})$  that guarantees eventual Phase 3 transition. The numerical simulation places the Phase 2-to-3 crossing at approximately 2015—the same year in which Figure 3 shows Japan's Phillips curve slope turning negative.

**Remark 4** (Interpretation of  $\bar{\lambda}$ ). *The threshold  $\bar{\lambda}$  is an upper bound: for any positive labor-decline rate below  $\bar{\lambda}$ , the gap between demand and supply growth rates is positive, so the capital overhang is eroded over time and Phase 3 is eventually reached. The speed of the transition depends on  $\lambda_t$ :*

larger  $\lambda_t$  (faster labor decline) widens  $g_{Yd} - g_{Y^*}$ , accelerating the Phase 3 arrival. The simulation calibrated to Japan shows that approximately 20 years of  $I_t = 0$  (from 1995 to 2015) suffice to erode the overhang, consistent with Japan's observed timeline. Phase 2. The simulation calibrated to Japan shows that approximately 20 years of  $I_t = 0$  (from 1995 to 2015) suffice to erode the overhang, consistent with Japan's observed timeline.

### 3.5 Proposition 4: Absorption by Expected Inflation

**Proposition 5** (Expectations absorption). *Under rational (or near-rational) expectations, if agents observe the demographic trajectory  $\{n_t^Y, n_t^W, n_t^O\}_{t=0}^\infty$  and understand the phase model, then  $\mathbb{E}_t[\pi_{t+1}]$  incorporates the long-run demographic trend. In a regression of  $\pi_t$  on  $\tilde{y}_t$ ,  $\mathbb{E}_t[\pi_{t+1}]$ , and demographic variables, the demographic variables lose explanatory power once  $\mathbb{E}_t[\pi_{t+1}]$  is included.*

*Proof.* The NKPC (19) can be iterated forward:

$$\pi_t = \kappa \sum_{s=0}^{\infty} \beta^s \mathbb{E}_t[\tilde{y}_{t+s}] + \gamma \sum_{s=0}^{\infty} \beta^s \mathbb{E}_t[\omega_{t+s}].$$

The discounted sum  $\sum \beta^s \mathbb{E}_t[\omega_{t+s}]$  is a sufficient statistic for the entire future path of demographics. If expectations  $\mathbb{E}_t[\pi_{t+1}]$  are formed rationally, they already embed this discounted sum. Adding current demographics  $\omega_t$  as a regressor alongside  $\mathbb{E}_t[\pi_{t+1}]$  is therefore redundant: the information in  $\omega_t$  is already contained in  $\mathbb{E}_t[\pi_{t+1}]$ . ■

**Empirical correspondence.** Table 4, Model 4: when expected inflation  $\pi_{it}^e$  is included alongside demographic variables, the  $F$ -test for joint significance of the age-structure variables fails to reject ( $p = 0.389$  for sample JT,  $p = 0.215$  for sample CF). This is not a sign of model failure but a *implication* of the model, though it also admits a more mechanical interpretation: expected inflation is a slow-moving variable that may absorb any low-frequency regressor, and demographics operate through the long-run inflation trend, which rational expectations absorb.

### 3.6 Proposition 5: Migration and Phase Reversal

**Proposition 6** (V-shaped recovery). *An exogenous increase in labor supply (e.g., through immigration) at date  $t_1$  during Phase 2 or early Phase 3 has the following effects:*

- (a) *The desired capital stock  $K_{t_1}^*$  rises, relaxing the irreversibility constraint ( $I_t > 0$  resumes).*
- (b) *Potential output  $Y_t^*$  increases, reducing or reversing the positive output gap.*
- (c) *The Phillips curve slope recovers toward its Phase 1 level.*

*If the immigration shock is sufficiently large, the economy reverts from Phase 3 to Phase 1.*

*Proof.* From (14),  $K_t^* = (\alpha A / (r + \delta))^{1/(1-\alpha)} L_t$ . An increase in  $L_t$  raises  $K_t^*$ . If  $K_t^* > (1 - \delta)K_{t-1}$ , then  $I_t > 0$  and the irreversibility constraint no longer binds. Capital accumulates toward the new  $K_t^*$ , raising  $Y_t^*$  and closing the positive output gap. The NKPC (19) then delivers  $\pi_t$  closer to  $\pi^*$ , and the Phillips curve slope  $\partial \pi_t / \partial \tilde{y}_t = \kappa$  is restored to its unconstrained level. ■

**Empirical correspondence.** Figure 3: Type III countries (Ireland, Luxembourg, Germany) exhibit more stable Phillips curve slopes than Type II countries (Japan, Korea, Portugal) at similar income levels. The migration-driven labor supply recovery in these countries reactivates Phase 1 dynamics, a pattern consistent with Proposition 5.

### 3.7 Corollary: The Double Headwind

**Corollary 1** (Nominal house price dynamics). *Let  $P_t^{rppi} = Q_t \cdot P_t^{cpi}$ , where  $Q_t$  is the real house price index and  $P_t^{cpi}$  is the consumer price level. In Phase 2:*

- (i)  *$Q_t$  declines (the companion paper, DINS 2026, documents this via the housing present-value relation);*
- (ii)  *$P_t^{cpi}$  declines (Propositions 1–2 of the present paper).*

*Hence  $P_t^{rppi}$  faces a “double headwind.” For Type III countries, both  $Q_t$  and  $P_t^{cpi}$  recover, producing a “double tailwind.”*

### 3.8 Summary: Model Predictions and Empirical Tests

Table 1 maps each proposition to the corresponding empirical result.

Table 1: Model Predictions and Empirical Correspondence

Proposition	Prediction	Result	Structural interpretation
1 (Phase 2 persistence)	$\hat{\alpha}_{old} < 0$	Tables 2–3	Excess supply from capital irreversibility
2 (PC flattening)	$\hat{\delta}_{old} < 0$	Table 5	Composition + level effects
3 (Phase 3 transition)	PC slope turns negative	Fig. 3 (JPN, 2015)	$\lambda_t \in (0, \bar{\lambda})$ under $I_t = 0$
4 (Expectations absorption)	$F$ -test insignificant	Table 4, M4	Demographics $\subset \mathbb{E}[\pi]$
5 (V-shaped recovery)	Stable PC slope	Fig. 3 (IRL, LUX)	Migration reverses Phase 2/3

### Note on Generality

The qualitative results (Propositions 1–5) hold for any production function  $F(K, L)$  that is concave, increasing, and homogeneous of degree one, provided that the irreversibility constraint (10) generates a wedge between actual and desired capital. The Cobb–Douglas specification is used only to derive the explicit threshold formula (24) and for calibration. In companion work, we extend the production side to a Normalized Quadratic (NQ) joint cost function following Diewert, Nomura, and Shimizu (2025), which allows variable elasticities of substitution between labor cohorts, capital types, and land—but the phase structure and the direction of all comparative statics are invariant to this generalization.

## 4 Empirical Specifications and Estimation Strategy

**Scope and limitations of the empirical design.** Before presenting the specifications, we state clearly what the reduced-form estimates can and cannot establish. The model’s core mechanism operates through the capital overhang ( $K_t - K_t^*$ ) and the irreversibility constraint ( $I_t = 0$ ). Ideally, the empirical analysis would directly measure these objects—for example, using capital-to-labor ratios, capacity utilization rates, or equipment scrapping data—and test whether the irreversibility channel

mediates the effect of demographics on inflation. The current design does not do this. Instead, it uses age-structure variables and an HP-filtered output gap as reduced-form proxies and asks whether the *patterns* in the data are consistent with the model’s predictions. The output gap, in particular, is an imperfect proxy: the two-sided HP filter uses future information, is unstable at endpoints, and may mechanically interact with low-frequency demographic variables. We therefore interpret the estimates as documenting *associations consistent with the irreversibility mechanism* rather than as direct tests of the mechanism itself. Causal identification of the demographic–inflation link—for example, using cohort-based shift-share instruments or subnational panels with policy-induced demographic shocks—remains an important open problem.

## 4.1 Specifications

Let  $N_{it}$  denote the total population of country  $i$  in year  $t$ , partitioned into  $J = 17$  five-year age groups with shares  $s_{jit} = N_{jit}/N_{it}$ . Following Fair and Dominguez (1991), we parameterise the age-structure effect using a fourth-order Almon polynomial with the zero-sum constraint  $\sum_j \alpha_j = 0$ , which reduces the 17 share regressors to four constructed variables  $\tilde{s}_{pit}$  ( $p = 1, \dots, 4$ ):

$$y_{it} = \mu + \text{PopDist}_{it} + X_{it}\beta + u_{it} \quad (27)$$

$$\text{PopDist}_{it} = \alpha_1 s_{1it} + \alpha_2 s_{2it} + \dots + \alpha_J s_{Jit}$$

Because the polynomial imposes smoothness that may obscure discrete breaks at labour-force-entry and retirement ages, we also estimate a three-generation model that divides the population into young (0–14), working-age (15–64), and elderly (65+), imposing  $\alpha_{yng} + \alpha_{wrk} + \alpha_{old} = 0$ :

$$\text{PopDist}_{it} = \alpha_{yng} \tilde{s}_{yng,it} + \alpha_{old} \tilde{s}_{old,it}, \quad \tilde{s}_{g,it} \equiv s_{g,it} - s_{wrk,it} \quad (28)$$

These building blocks enter five models, each designed to test a specific aspect of the framework:

- **Model A** (Appendix): Almon polynomial—tests the overall age-structure effect on long-run

inflation.

- **Model B** (equation 30): Three-generation baseline—yields directly interpretable coefficients for the young, working-age, and elderly groups.
- **Model C** (equation 29): DCCEMG—accommodates slope heterogeneity and cross-sectional dependence.
- **Model D** (equation 31): Augmented Phillips curve—tests hypothesis **H1** (absorption by expected inflation).
- **Model E** (equation 32): Interaction model—tests hypothesis **H2** (age-dependent Phillips curve slope).

The specific equations are presented alongside the results in Section 5.

## 4.2 Estimation Strategy

Three econometric challenges arise in long-span international panel data. First, unobserved country-specific heterogeneity (fiscal institutions, monetary regimes, price-control histories) must be absorbed. Second, the inclusion of lagged inflation introduces Nickell bias when  $T$  is moderate (Nickell, 1981). Third, common global shocks—oil prices, commodity cycles, synchronised monetary easing—generate cross-sectional dependence that biases standard errors and may bias point estimates.

For Models A and B, we use two-way (country and year) fixed-effects estimation with lagged inflation to approximate an error-correction dynamic. For Models D and E, which include the potentially endogenous output gap, we employ the system GMM estimator of Blundell and Bond (1998); instrument validity is assessed via the Sargan, Hansen, and AR(2) diagnostics.

Model C deploys the Dynamic Common Correlated Effects Mean Group (DCCEMG) estimator

of Chudik and Pesaran (2015):

$$\pi_{it} = \mu_i + \sum_g \alpha_{gi} s_{it}^g + \beta_{1i} \Delta n_{it} + \beta_{2i} \Delta l_{it}^e + \sum_{l=1}^L \rho_{li} \pi_{it-l} + \sum_{l=0}^{p_{\bar{z}}} \psi'_{li} \bar{z}_{t-l} + e_{it} \quad (29)$$

where  $\bar{z}_t$  stacks the cross-sectional averages of all regressors. The CCE lag order is  $p_{\bar{z}} = \lfloor T^{1/3} \rfloor = 3$  (Chudik et al., 2013). The Pesaran (2021) CD test is applied to each specification to verify that CCE terms adequately absorb cross-sectional dependence.

## 5 Data and Estimation Results

### 5.1 Data

**Variables.** CPI inflation is taken from the World Development Indicators (WDI). Population by 17 five-year age groups, total population, and life expectancy at birth are also drawn from the WDI. Real GDP is RGDPNA from Penn World Table 10.0. The output gap is the cyclical component of log real GDP extracted by a two-sided Hodrick-Prescott filter.<sup>5</sup> Expected inflation is the one-year-ahead December forecast from Consensus Forecast (CF).

**Sample.** We begin with all countries for which CPI and population data are available from 1965 and exclude those whose inflation exceeded 35% per annum on multiple occasions. The exclusion criterion is motivated by the model’s focus on moderate-inflation regimes: in hyperinflationary episodes, monetary and fiscal factors overwhelm demographic channels, and the NKPC framework becomes inapplicable. The resulting sample of 38 countries is listed in Table A3. It nests the 22 advanced-economy countries of Juselius and Takats (2021) (“sample JT”), all of which are OECD members classified as high-income by the World Bank. The 16 additional countries include

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<sup>5</sup>Hamilton (2018) identifies problems with the HP filter, particularly the use of future information and instability at endpoints. We verified robustness using a one-sided HP filter and the Hamilton regression-based filter; results are qualitatively unchanged. We acknowledge that the two-sided HP gap is not an ideal measure of the theoretical output gap  $\tilde{y}_t$ , particularly under structural demographic change where the trend itself is shifting. A production-function-based gap or capacity utilization measure would provide a more direct empirical counterpart to the model; we leave this extension to future work.

upper-middle-income (4) and lower-middle-income (8) economies from ASEAN (4), Latin America (4), Sub-Saharan Africa (3), and the Middle East and North Africa (2), providing substantially more variation in both demographic structure and inflation dynamics. For the Phillips curve models requiring expected inflation, a 30-country subsample (“sample CF”) is used.

**Descriptive overview.** Figure 1 plots the 5th percentile, median, and 95th percentile of six key variables, separately for sample JT (blue) and the full 38-country sample (grey). Median inflation trajectories are similar, but the 95th percentile reveals that the expanded sample captures economies with substantially higher and more volatile inflation. The population variables confirm that sample JT is concentrated among low-growth, aging economies, while the 38-country sample includes economies still in the demographic-bonus phase.

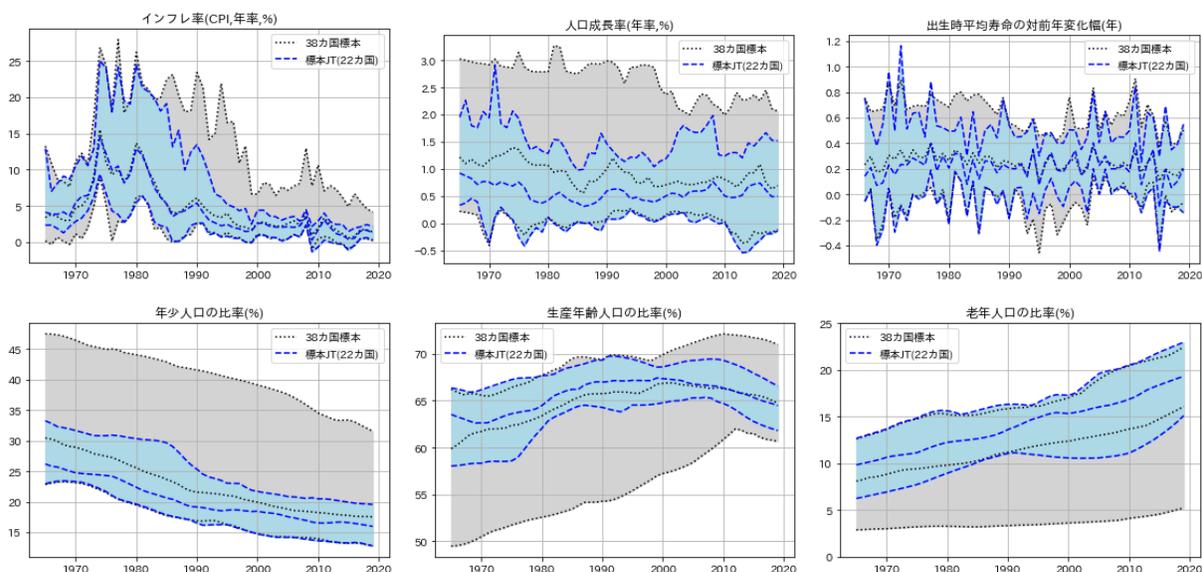


Figure 1: Distribution of Key Variables by Sample. *Notes:* Computed from WDI data. Each panel shows the 5th percentile, median, and 95th percentile by year. Blue: sample JT (22 countries). Grey: 38-country sample.

## 5.2 Long-Run Age-Structure Effects

The theoretical model (Section 2) is built on a three-generation structure; accordingly, our primary specification divides the population into young (0–14), working-age (15–64), and elderly (65+). As

a robustness check, Appendix Table A1 reports estimates from a fourth-order Almon polynomial specification that imposes smoothness across all 17 five-year age groups; the results are qualitatively identical. Similarly, the DCCEMG long-run coefficient estimates (Appendix Table A2) confirm that the baseline findings are robust to slope heterogeneity and cross-sectional dependence.

The three-generation specification yields directly interpretable coefficients for each age group:

$$\pi_{it} = \mu + \sum_g \alpha_g s_{it}^g + \beta_1 \Delta n_{it} + \beta_2 \Delta l_{it}^e + \sum_{l=1}^L \rho_l \pi_{it-l} + \varepsilon_{it} \quad (30)$$

Table 2 delivers the paper’s first key finding. The young-population coefficient is significantly positive in both samples, confirming that a growing youth cohort is inflationary. The elderly coefficient is insignificant in sample JT but significantly *negative* in the 38-country sample ( $-0.102$ ,  $p < 0.10$  in the  $L = 1$  specification). This pattern is consistent with the theoretical prediction that Channels 2 (political economy) and 3 (shelter costs) dominate Channel 1 (dissaving), and that the dominance becomes detectable only when the sample includes economies with sufficient demographic diversity. The age-structure  $F$ -test rejects joint exclusion at the 1% level throughout.

Figure 2 visualises these results. The upper panels plot the Almon polynomial coefficients (orders 3–6); the lower panels overlay the three-generation estimates with  $\pm 2$  standard-error bands. The polynomial curves reproduce the hump-shaped pattern of Juselius and Takats (2021): young and middle-aged dependent groups are inflationary, the prime working-age group is deflationary, and the very elderly show a sharp negative turn that may partly reflect the smoothness constraint. The three-generation model captures the same qualitative pattern without imposing continuity, making it our preferred baseline.

### 5.3 The Phillips Curve and Age Structure

We now ask whether age structure retains explanatory power once the Phillips curve’s standard determinants—the output gap, expected inflation, and lagged inflation—are controlled for. The

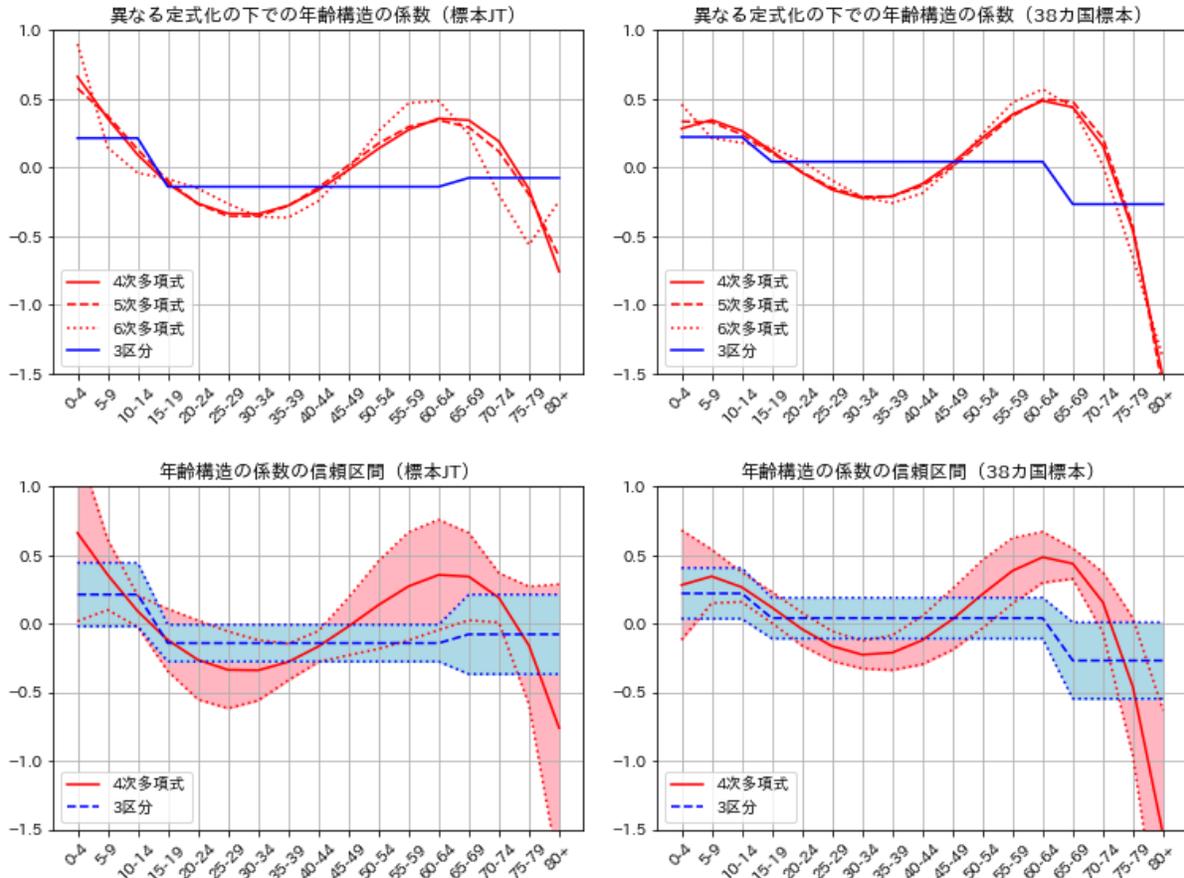


Figure 2: Estimated Age-Structure Coefficients. *Notes:* Upper panels: Almon polynomial specifications (orders 3–6) for sample JT (left) and 38 countries (right). Lower panels: three-generation model with  $\pm 2$  standard-error confidence bands.

Table 2: Three-Generation Model, Two-Way FE Estimation

	Sample JT (22 countries)			38 countries			
	(1)	(2)	(3)	(1)	(2)	(3)	
$s_{it}^{yng}$	0.220** (0.092)	0.066* (0.035)	0.073* (0.036)	0.214** (0.086)	0.085** (0.035)	0.083** (0.036)	
$s_{it}^{wrk}$	-0.134** (0.053)	-0.043** (0.020)	-0.049** (0.021)	0.072 (0.064)	0.016 (0.028)	0.016 (0.029)	
$s_{it}^{old}$	-0.086 (0.104)	-0.023 (0.044)	-0.025 (0.046)	-0.285** (0.122)	-0.102* (0.053)	-0.099* (0.055)	
$\Delta n_{it}$	1.180* (0.609)	0.419* (0.233)	0.423* (0.237)	0.474 (0.312)	0.280** (0.128)	0.283** (0.126)	<i>Notes:</i>
$\pi_{it-1}$		0.695*** (0.040)	0.737*** (0.036)		0.617*** (0.051)	0.605*** (0.043)	
$\pi_{it-2}$			-0.056 (0.033)			0.020 (0.042)	
Observations	1210	1188	1166	2090	2052	2014	
Years ( $T$ )	55	54	53	55	54	53	
$R^2$	0.609	0.856	0.857	0.383	0.712	0.715	
Lags of $\pi_{it}$	None	$L = 1$	$L = 2$	None	$L = 1$	$L = 2$	
Age structure $F(p)$	0.000	0.000	0.000	0.000	0.000	0.000	
Year FE $F(p)$	0.000	0.000	0.000	0.000	0.000	0.000	

Country-clustered robust standard errors in parentheses. \* $p < 0.10$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ .

estimation equation is:

$$\pi_{it} = \mu + \sum_g \alpha_g s_{git} + \beta_1 \Delta n_{it} + \beta_2 \Delta I_{it}^e + \beta_3 \hat{y}_{it} + \sum_{l=1}^L \rho_l \pi_{it-l} + \rho_f \pi_{it}^e + \varepsilon_{it} \quad (31)$$

The sample period is 1990–2019, the window for which CF expected inflation data are available.

Table 3 presents system GMM estimates of four nested models. In the baseline backward-looking Phillips curve (BLPC, Model 1), the output gap coefficient is 0.177 (JT) and 0.193 (CF-30), both significant at 1%. The autoregressive coefficients (0.515 and 0.373) are well below unity. Adding expected inflation (Model 2, NKPC) dramatically alters the picture: the gap coefficient falls by 30–50%, the autoregressive term becomes insignificant, and expected inflation (0.756 and 0.685) emerges as the dominant explanatory variable.

Model 3 augments the BLPC with demographics. The  $F$ -test rejects joint exclusion of age structure at the 5% level in the 30-country sample ( $p = 0.000$ ) and marginally in the JT sample ( $p = 0.052$ ). The elderly coefficient is significantly negative in the larger sample ( $-0.073$ ,  $p < 0.05$ ). Model 4 adds *both* demographics and expected inflation. The  $F$ -test for age structure now fails to reject ( $p = 0.389$  and  $0.215$ ). This is the paper’s second key finding and directly supports **H1**: once expected inflation is controlled for, age structure adds no further explanatory power for short-run inflation, implying that the demographic effect operates through the long-run inflation trend that expectations embody.

## 5.4 Age Structure and the Slope of the Phillips Curve

To test hypothesis **H2**—that age structure conditions the sensitivity of inflation to the output gap—we allow the gap coefficient to vary with demographic composition:

$$\pi_{it} = \mu + \sum_g \alpha_g s_{it}^g + \beta_1 \Delta n_{it} + \left( \beta_3 + \sum_g \delta_g (s_{it}^g - \bar{s}_i^g) \right) \hat{y}_{it} + \sum_{l=1}^L \rho_l \pi_{it-l} + \varepsilon_{it} \quad (32)$$

The interaction terms use within-group-demeaned age shares, ensuring that the  $\delta_g$  coefficients capture *changes* in demographic composition within each country rather than cross-country level

Table 3: Phillips Curve Estimation, Two-Way System GMM,  $L = 1$

	Sample JT (22 countries)				Sample CF (30 countries)			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
$S_{it}^{yng}$			0.006 (0.025)	-0.016 (0.012)			0.114*** (0.028)	0.066* (0.037)
$S_{it}^{wrk}$			0.028 (0.017)	0.014 (0.011)			-0.041*** (0.013)	-0.037 (0.029)
$S_{it}^{old}$			-0.034* (0.017)	0.003 (0.008)			-0.073** (0.031)	-0.029 (0.024)
$\Delta n_{it}$			-0.009 (0.157)	0.047 (0.078)			-0.247 (0.194)	-0.135 (0.139)
$\pi_{it}^e$		0.756*** (0.145)		0.766*** (0.133)		0.685*** (0.043)		0.543*** (0.095)
$\hat{y}_{it}$	0.177*** (0.045)	0.125*** (0.035)	0.177*** (0.048)	0.122*** (0.037)	0.193*** (0.040)	0.098*** (0.033)	0.198*** (0.042)	0.108*** (0.031)
$\pi_{it-1}$	0.515*** (0.089)	0.135 (0.105)	0.517*** (0.092)	0.130 (0.100)	0.373*** (0.083)	0.151* (0.082)	0.401*** (0.085)	0.174** (0.073)
Observations	638	635	638	635	870	852	870	852
Age struct. $F(p)$			0.052	0.389			0.000	0.215
Sargan ( $p$ )	0.180	0.167	0.183	0.155	0.068	0.000	0.219	0.000
Hansen ( $p$ )	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
AR(2) ( $p$ )	0.337	0.896	0.336	0.894	0.462	0.277	0.512	0.270

Notes: Country-clustered robust standard errors in parentheses. \* $p < 0.10$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ . Models (1)–(2):

without demographics. Models (3)–(4): with demographics.

differences.

Table 4 presents the third key finding. In sample JT, a rising youth share significantly steepens the Phillips curve ( $\delta_{yng} = 2.525$ ,  $p < 0.05$ ) while a rising elderly share significantly flattens it ( $\delta_{old} = -3.674$ ,  $p < 0.05$ ). In the 38-country sample, the elderly interaction remains significant ( $\delta_{old} = -1.380$ ,  $p < 0.05$ ), though the youth interaction loses significance. This asymmetry is consistent with the conceptual framework: Channel 1 predicts that the natural-rate wedge is state-dependent, and the state dependence is most pronounced during the onus period.

Figure 3 maps the time path of each country's Phillips curve slope, computed from the Model (2) estimates. The red horizontal line marks the pooled long-run effect (0.314). The figure reveals a widespread downward trend in the slope, concentrated among high-income, rapidly aging economies. Japan stands out: its estimated slope turns negative after 2015, implying that a positive output gap is associated with *falling* rather than rising inflation. Korea, Malta, and Portugal show similar tendencies in the later years. Countries where the slope has remained stable—Côte d'Ivoire, Egypt, Honduras, South Africa—are precisely those where population aging has progressed most slowly.

## 5.5 Very-Long-Run Inflation Projections

As a supplementary exercise, we project the inflation trend through 2100 using the UN World Population Prospects 2022 (Appendix Figure A1). The projections are conditional on the estimated reduced-form model and the population assumptions; they should be interpreted as illustrative counterfactuals rather than forecasts, since they do not account for policy-regime changes, technological shocks, or other structural breaks. We include them in the Appendix for completeness but do not treat them as central evidence.

## 6 Structural Interpretation

The reduced-form estimates are consistent with the model's predictions. This section maps each key finding to the theoretical framework, while noting the important gap between the model's state

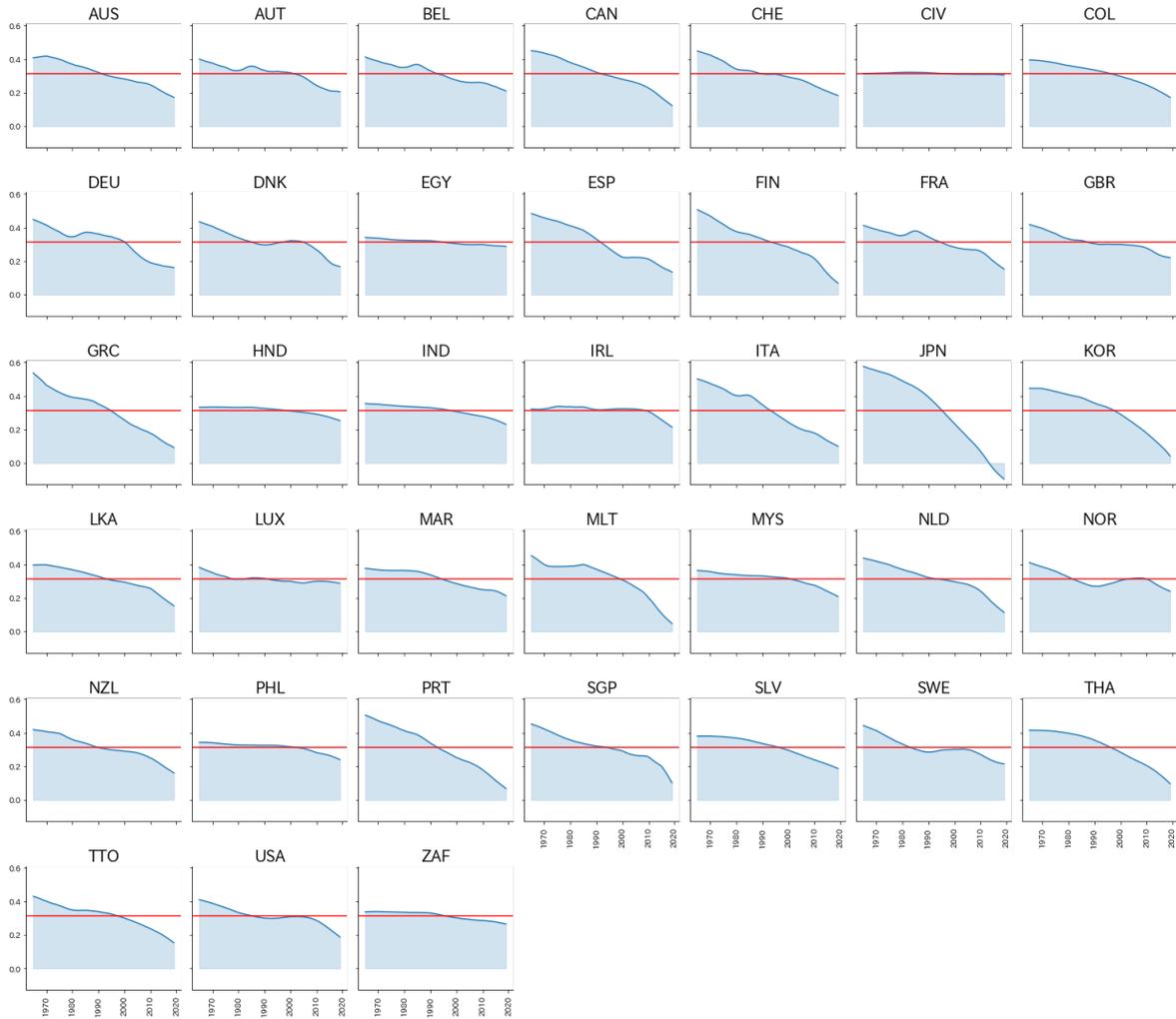


Figure 3: Time-Varying Phillips Curve Slope, 38-Country Sample. *Notes:* Point estimates of the output gap coefficient over time, computed from Table 4, Model (2). Red line: pooled long-run effect (0.314). Country codes defined in Table A3.

Table 4: Backward-Looking Phillips Curve with Age-Dependent Slope, System GMM

	Sample JT (22 countries)		38 countries		
	(1)	(2)	(1)	(2)	
$s_{it}^{yng}$	0.125*** (0.028)	0.120*** (0.026)	0.107*** (0.026)	0.107*** (0.025)	
$s_{it}^{wrk}$	-0.094*** (0.027)	-0.098*** (0.029)	-0.043 (0.028)	-0.044 (0.028)	
$s_{it}^{old}$	-0.032 (0.021)	-0.023 (0.022)	-0.064** (0.028)	-0.063** (0.028)	
$\Delta n_{it}$	-0.169 (0.217)	-0.107 (0.214)	-0.374** (0.151)	-0.372** (0.152)	
$\hat{y}_{it}$	0.345*** (0.046)	0.349*** (0.057)	0.209*** (0.043)	0.213*** (0.036)	
$(s_{it}^{yng} - \overline{s_i^{yng}}) \times \hat{y}_{it}$		2.525** (0.908)		0.758 (0.569)	<i>Notes: Country-clustered robust</i>
$(s_{it}^{wrk} - \overline{s_i^{wrk}}) \times \hat{y}_{it}$		1.149 (1.255)		0.622 (0.534)	
$(s_{it}^{old} - \overline{s_i^{old}}) \times \hat{y}_{it}$		-3.674** (1.323)		-1.380** (0.647)	
$\pi_{it-1}$	0.640*** (0.036)	0.659*** (0.039)	0.449*** (0.059)	0.450*** (0.058)	
$\pi_{it-2}$	-0.110** (0.039)	-0.105** (0.038)	-0.129* (0.067)	-0.129* (0.064)	
Observations	1166	1166	2014	2014	
Sargan ( $p$ )	0.064	0.134	0.123	0.064	
Hansen ( $p$ )	1.000	1.000	1.000	1.000	
AR(2) ( $p$ )	0.531	0.379	0.314	0.340	

standard errors in parentheses. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

variables and the available empirical proxies.

**An important caveat on state variables.** The model’s core mechanism operates through the capital overhang  $K_t - K_t^*$  and the irreversibility constraint  $I_t = 0$ . Ideally, the empirical analysis would directly measure these objects—for example, using capital-stock-to-labor ratios, capacity utilization, building vacancy rates, or equipment scrapping rates. The current empirical design instead relies on age-structure variables and the output gap as reduced-form proxies. While the model provides the mapping between these proxies and the underlying state variables, a more convincing test would require direct measurement of the capital overhang and its phase-dependent evolution. We regard this as the most important direction for future empirical work.

## 6.1 The Negative Elderly Coefficient and Phase 2

The significantly negative elderly coefficient in the 38-country sample (Table 2) is consistent with the dominance of Phase 2 dynamics across the sample period (1965–2019) for economies in the onus period. Proposition 1 provides a structural interpretation: when  $I_t = 0$  binds, potential output  $Y_t^*$  declines at rate  $\alpha\delta + (1 - \alpha)\lambda_t$  (equation 17), which is slower than the decline in aggregate demand. However, we acknowledge that this interpretation cannot be distinguished from alternative channels (e.g., natural-rate depression, globalization effects) without direct measurement of the capital overhang.

## 6.2 Structural Decomposition of the Interaction Term

Table 4 reports  $\hat{\delta}_{old} = -3.674$  (sample JT) and  $\hat{\delta}_{old} = -1.380$  (38 countries): a rising elderly share is associated with a flatter Phillips curve slope. Proposition 2 suggests two structural mechanisms.

The *composition effect* arises because aging economies spend most of Phase 2 with  $\tilde{y}_t < 0$ ; if the Phillips curve is asymmetric, the observed slope in the negative-gap region is mechanically flatter. The *level effect* arises because the direct demographic term  $\gamma\omega_t$  shifts the NKPC intercept downward. Both effects predict  $\delta_{old} < 0$ .

### 6.3 Japan After 2015: Suggestive Evidence

Figure 3 shows that Japan’s estimated Phillips curve slope turns negative after approximately 2015. We interpret this as *suggestive of* the onset of the supply-constrained phase, consistent with Propositions 3a–3b. Several pieces of supporting evidence are consistent with this interpretation: Japan’s unemployment rate fell below 2.5% after 2017, the job-openings-to-applicants ratio exceeded 1.5 (the highest since 1973), and nominal wage growth turned positive after two decades of stagnation.

The illustrative calibration ( $\alpha = 0.35$ ,  $\delta = 0.06$ ,  $\eta = 0.85$ ) places the model’s Phase 2-to-3 crossing at approximately 2015, though this should be interpreted cautiously: the simulation assumes constant parameters and exogenous demographics, and the 2015 date is sensitive to the initial capital overhang and the demand elasticity  $\eta$ .

**Quantitative fit.** Figure 4 (panel a) overlays the model’s inflation path with Japan’s actual CPI inflation. The model captures only the demographic channel and therefore cannot reproduce oil-shock spikes, consumption-tax hikes, or monetary policy effects. Nevertheless, the five-year moving averages (panel b) show a trend correlation of 0.91, indicating that the irreversibility mechanism tracks the *direction* of Japan’s long-run inflation decline. The model’s Phase 2 mean inflation (−0.9%) is approximately 1 percentage point below the actual mean (+0.1%), suggesting that other channels (monetary accommodation, fiscal transfers, global commodity prices) partially offset the demographic deflationary pressure during 1995–2015. We interpret this as indicating that the demographic-irreversibility mechanism accounts for the *direction and approximate magnitude* of Japan’s trend disinflation, while the remaining variation reflects conventional macroeconomic forces that the parsimonious model deliberately abstracts from.

**Zero lower bound interaction.** A natural question is whether the zero lower bound (ZLB) on nominal interest rates, rather than the irreversibility mechanism, explains Japan’s prolonged low inflation. Figure 4 (panels c–d) addresses this through a ZLB counterfactual. When the ZLB constraint  $i_t \geq 0$  is imposed, Phase 2 deflation deepens by approximately 4 percentage points

(panel c): the central bank cannot lower rates enough to offset the excess-supply gap, amplifying the deflationary pressure. Crucially, however, the *timing of the Phase 3 transition is identical* with and without ZLB (panel d): the output gap crosses zero in 2015 in both cases. This is because the Phase 3 onset is determined by the capital depreciation rate  $\delta$  and the labor-force decline rate  $\lambda_t$ —real-side variables that are independent of the monetary policy regime. The ZLB amplifies the *depth* of Phase 2 but does not affect the *duration*. This result provides a sharp distinction from the secular stagnation literature (Eggertsson et al., 2019), in which the ZLB is the proximate cause of persistent deflation: in our model, the irreversibility constraint is the deeper structural cause, and the ZLB is an amplifier.

We stress that a formal structural break test, sectoral analysis of labor shortages, and vacancy-to-unemployment evidence would strengthen this interpretation substantially. These are beyond the scope of the current reduced-form design but represent important avenues for future work.

#### **6.4 The Expectations Absorption Result: A Limitation**

Table 3 (Model 4) shows that age-structure variables lose significance once expected inflation is included ( $F$ -test:  $p = 0.389$  for sample JT,  $p = 0.215$  for sample CF). The model (Proposition 4) is consistent with this pattern, since rational expectations embed the demographic trajectory.

However, this result is better understood as a *limitation* of the reduced-form design than as a confirmation of the theory. Expected inflation is a slow-moving variable that will tend to absorb any low-frequency regressor, including demographics, regardless of the underlying mechanism. The fact that age structure becomes insignificant conditional on expected inflation tells us that demographics operate through the long-run inflation trend—but it does not tell us *why*. The irreversibility mechanism is one explanation; shifts in monetary policy credibility, globalization, or technology are others. Distinguishing among these requires either a decomposition of expected inflation into short-run and long-run components (requiring richer expectations data than the Consensus Forecast series, which covers only 1990–2019), or an identified design that isolates the demographic channel. We therefore do not treat this result as strong evidence for or against the model.

**Quantitative Analysis: Japan Calibration**  
**Demographic Channel Explanatory Power and ZLB Interaction**

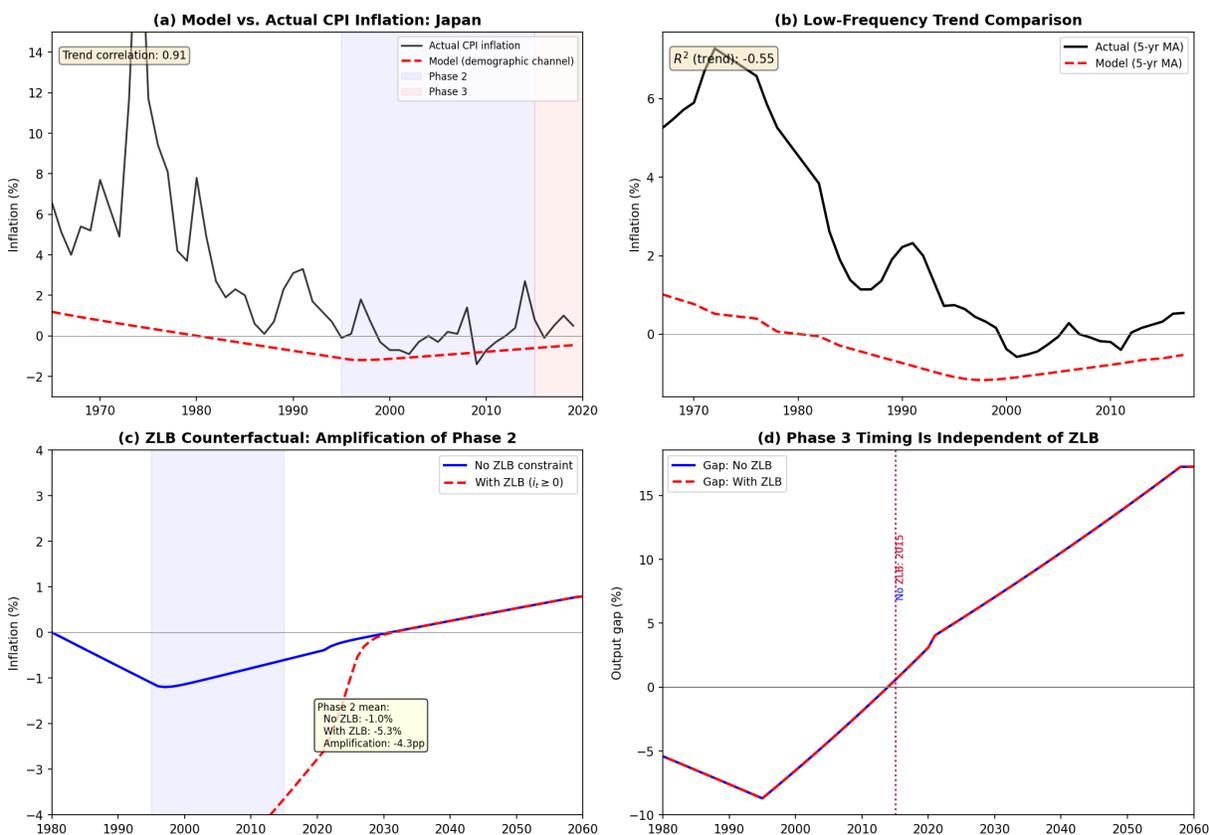


Figure 4: Quantitative Fit and ZLB Counterfactual: Japan. *Notes:* Panel (a): model inflation (demographic channel only) vs. actual CPI inflation (World Bank WDI). Panel (b): five-year moving averages; trend correlation 0.91. Panel (c): ZLB counterfactual—ZLB amplifies Phase 2 deflation by approximately 4 pp but does not affect Phase 3 timing. Panel (d): output gap with and without ZLB; Phase 3 onset at 2015 in both cases.

## 6.5 Type III Countries as Informal Identification

Type III countries—Ireland, Luxembourg, and partially Germany—experienced migration-driven population reversals that provide the closest approximation to a natural experiment in our design. Figure 3 shows that these countries exhibit more stable Phillips curve slopes than Type II countries at similar income levels. If the slope flattening were driven by omitted institutional trends correlated with aging, exogenous migration-driven labor supply shocks would not systematically restore the slope. While this pattern is *consistent with* Proposition 5, it falls short of formal causal identification: migration itself is endogenous to economic conditions, and the number of Type III countries is small.

## 6.6 Multi-Country Calibration: Generality of the Phase Structure

To demonstrate that the three-phase dynamics are not specific to Japan, we calibrate the model for four representative countries spanning the three demographic types: Japan and Korea (Type II, irreversible decline), India (Type I, sustained growth), and Ireland (Type III, V-shaped recovery). Each country’s demographic trajectory is based on UN WPP 2022 medium-variant projections; the structural parameters ( $\alpha$ ,  $\delta$ ) are calibrated to country-specific data.

Figure 5 presents the results. Four patterns are consistent with the model’s generality.

*First*, the phase timeline (panel i) shows that Japan enters Phase 3 around 2016 and Korea follows with approximately a 25-year lag (circa 2041)—consistent with the lagged Phillips curve flattening observed for Korea in Figure 3. India remains in Phase 1–2 throughout, with no Phase 3 transition by 2100, reflecting its continued labor-force growth.

*Second*, Ireland’s Phase 3 entry (circa 2033) is delayed and attenuated relative to the Type II trajectory, because the Celtic Tiger immigration boom of the 1990s–2000s partially replenished the working-age population (Proposition 5). The output gap for Ireland remains smaller than for Japan or Korea at every comparable phase.

*Third*, the Phillips curve slopes (panel e) reproduce the cross-country heterogeneity documented in Figure 3: steep and stable for India (Type I), declining sharply for Japan and Korea (Type II), and

intermediate for Ireland (Type III).

*Fourth*, the threshold  $\bar{\lambda}$  varies across countries as predicted by equation (24): India ( $\alpha = 0.40$ ) has a higher threshold ( $\bar{\lambda} = 8.0\%$ ) than Japan ( $\alpha = 0.35$ ,  $\bar{\lambda} = 10.5\%$ ), while Ireland ( $\alpha = 0.30$ ,  $\bar{\lambda} = 13.0\%$ ) has the widest range of labor-decline rates compatible with Phase 3 transition. the Phase 3 transition. This cross-country variation in  $\bar{\lambda}$  provides a testable prediction for future empirical work.

## 6.7 Connection to the Companion Paper

A companion paper (Deng et al., 2026) documents that unanticipated aging depresses real house prices through the housing present-value relation. Combined with the present paper’s finding that aging is associated with lower CPI inflation, nominal house prices in aging economies may face pressure from both multiplicands ( $P_t^{rppi} = Q_t \times P_t^{cpi}$ ). We note this connection but do not develop it further here.

## 7 Conclusion

This paper has proposed that irreversible capital accumulation, interacting with demographic decline, can generate phase-dependent inflation dynamics: a prolonged period of excess supply (when durable capital cannot be rapidly scrapped) followed by an eventual supply-constrained regime (when depreciation erodes the overhang and the labor force shrinks). We formalize this mechanism in a three-generation OLG model and show that reduced-form patterns in a 38-country panel over 1965–2019 are broadly consistent with the model’s predictions.

We view the paper’s contribution as primarily theoretical: the irreversibility mechanism provides a unified account of why aging economies may experience deflation, Phillips curve flattening, and eventual supply-constrained inflation in sequence. The international panel evidence disciplines the theory but does not, by itself, establish causation. The most important limitations are: (i) the absence of direct measurement of the model’s state variables (capital overhang, irreversibility constraint);

**OLG-NKPC Model: Multi-Country Calibration**  
**Demonstrating Generality of the Three-Phase Structure Across Country Types**

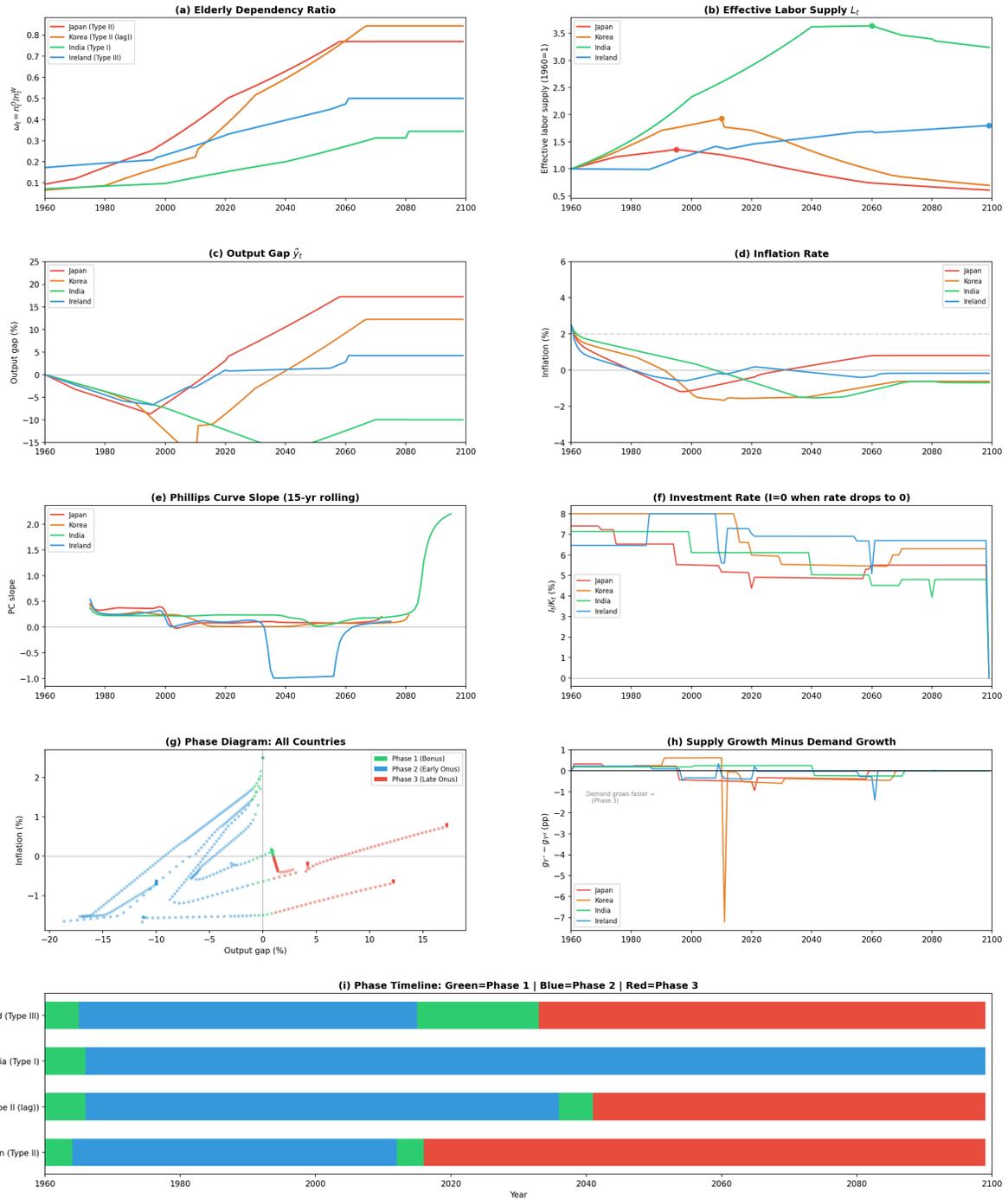


Figure 5: Multi-Country Calibration of the OLG-NKPC Model. *Notes:* Four representative countries calibrated to UN WPP 2022 demographic trajectories. Japan ( $\alpha = 0.35$ ,  $\delta = 0.06$ ); Korea ( $\alpha = 0.33$ ,  $\delta = 0.07$ ); India ( $\alpha = 0.40$ ,  $\delta = 0.05$ ); Ireland ( $\alpha = 0.30$ ,  $\delta = 0.065$ ). Panel (i) shows the phase timeline: green = Phase 1 (bonus), blue = Phase 2 (early onus), red = Phase 3 (late onus).

(ii) the reliance on two-way fixed effects and GMM rather than an identified causal design; (iii) the use of HP-filtered output gaps, which may mechanically interact with low-frequency demographic variables; and (iv) the small number of Type III countries available for the migration-based informal identification.

Several extensions would substantially strengthen the empirical case. Direct measurement of the capital overhang using capacity utilization, vacancy rates, or capital-to-labor ratios; cohort-based shift-share instruments for age structure; subnational panels with policy-induced demographic shocks; production-function-based output gaps; and formal structural break tests around the hypothesized Phase 2-to-3 transition—all represent important directions for future work. The model's predictions for the post-2019 period, including the COVID-19 supply disruptions and subsequent global inflation, provide a natural out-of-sample test.

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# Appendix

## A1. Almon Polynomial Estimation (Table A1)

As a robustness check on the three-generation specification, we estimate a fourth-order Almon polynomial that smoothly parameterizes the age-structure effect across all 17 five-year age groups. The results (Table A1) are qualitatively identical to the three-generation baseline (Table 2).

Table A1: Almon Polynomial Model, Two-Way FE Estimation

	Sample JT (22 countries)			38 countries		
	(1)	(2)	(3)	(1)	(2)	(3)
$\tilde{s}_{1it}$	-0.017 (0.240)	-0.106 (0.108)	-0.128 (0.107)	0.560** (0.230)	0.178* (0.101)	0.168 (0.105)
$\tilde{s}_{2it}(\times 10)$	-0.679 (0.487)	-0.018 (0.162)	0.004 (0.166)	-1.884*** (0.541)	-0.670*** (0.227)	-0.644** (0.244)
$\tilde{s}_{3it}(\times 10^2)$	0.987** (0.471)	0.170 (0.109)	0.166 (0.125)	1.999*** (0.499)	0.741*** (0.205)	0.718*** (0.225)
$\tilde{s}_{4it}(\times 10^3)$	-0.359** (0.160)	-0.079** (0.034)	-0.081* (0.042)	-0.655*** (0.155)	-0.248*** (0.064)	-0.241*** (0.070)
$\Delta n_{it}$	1.228* (0.611)	0.467* (0.264)	0.481* (0.270)	0.804** (0.324)	0.389** (0.150)	0.385** (0.150)
$\pi_{it-1}$		0.669*** (0.040)	0.718*** (0.034)		0.595*** (0.051)	0.592*** (0.042)
$\pi_{it-2}$			-0.069* (0.035)			0.007 (0.045)
Observations	1210	1188	1166	2090	2052	2014
$R^2$	0.636	0.858	0.858	0.396	0.706	0.709
Lags of $\pi_{it}$	None	$L = 1$	$L = 2$	None	$L = 1$	$L = 2$
Age structure $F(p)$	0.012	0.001	0.001	0.004	0.002	0.007

Notes:

Country-clustered robust standard errors in parentheses. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

## A2. DCCEMG Estimation (Table A2)

Table A2 presents the DCCEMG long-run coefficient estimates. The CD test rejects the null of no cross-sectional dependence for models without CCE terms ( $p = 0.000$ ), but fails to reject once CCE terms are included (columns 3–4). In the preferred CCE-adjusted specifications, the young

coefficient remains positive and significant, the elderly coefficient is negative (reaching  $-3.758$ ,  $p < 0.05$  in the 38-country sample), and population growth is consistently inflationary.

Table A2: Three-Generation Model, MG Estimation of Long-Run Coefficients

	Sample JT (22 countries)				38 countries			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
$s_{it}^{yng}$	0.687*** (0.081)	1.345*** (0.250)	0.897* (0.469)	1.140** (0.517)	0.368 (0.234)	0.906** (0.352)	1.365* (0.813)	2.115** (0.908)
$s_{it}^{wrk}$	-0.613*** (0.145)	-0.608* (0.313)	-0.434* (0.237)	-0.071 (0.417)	-0.179 (0.299)	0.022 (0.515)	1.046 (0.841)	1.642 (1.020)
$s_{it}^{old}$	-0.074 (0.114)	-0.738** (0.365)	-0.464 (0.455)	-1.070* (0.623)	-0.189 (0.483)	-0.929 (0.752)	-2.411 (1.569)	-3.758** (1.816)
$\Delta n_{it}$	1.756* (1.023)	2.756 (2.297)	1.455** (0.612)	1.402** (0.691)	3.849*** (1.441)	5.107* (2.966)	3.858* (2.233)	5.924* (3.226)
$\Delta l_{it}^e$					0.004 (0.013)	0.006 (0.024)	-0.022 (0.014)	-0.019 (0.017)
Observations	1188	1166	1144	1144	2052	2014	1938	1938
$R^2$	0.214	0.200	0.727	0.627	0.353	0.328	0.678	0.570
AR lag ( $p_y$ )	1	2	1	2	1	2	1	2
CCE terms	No	No	Yes	Yes	No	No	Yes	Yes
CD stat.	43.24	41.87	-3.05	-2.92	63.70	62.15	-0.15	0.15
( $p$ -value)	0.000	0.000	0.002	0.003	0.000	0.000	0.885	0.883

Notes: Standard errors in parentheses. \* $p < 0.10$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ .

### A3. Very-Long-Run Inflation Projections (Figure A1)

Figure A1 projects the inflation trend through 2100 based on equation (30) with individual effects and three UN population variants. For Japan and Korea, the medium-variant projection shows continued decline until the 2060s, followed by a modest reversal as the elderly share stabilizes. These are conditional on the estimated model and should be interpreted as illustrative counterfactuals.

### A4. List of Sample Countries

Table A3: List of Sample Countries

Country	Code	Region	Income Group	JT	CF	OECD	ASEAN
<i>Juselius and Takats (2021) — 22 Countries</i>							
Australia	AUS	East Asia & Pacific	High income	○	○	○	—
Austria	AUT	Europe & Central Asia	High income	○	○	○	—
Belgium	BEL	Europe & Central Asia	High income	○	○	○	—
Canada	CAN	North America	High income	○	○	○	—
Switzerland	CHE	Europe & Central Asia	High income	○	○	○	—
Germany	DEU	Europe & Central Asia	High income	○	○	○	—
Denmark	DNK	Europe & Central Asia	High income	○	○	○	—
Spain	ESP	Europe & Central Asia	High income	○	○	○	—
Finland	FIN	Europe & Central Asia	High income	○	○	○	—
France	FRA	Europe & Central Asia	High income	○	○	○	—
United Kingdom	GBR	Europe & Central Asia	High income	○	○	○	—
Greece	GRC	Europe & Central Asia	High income	○	○	○	—
Ireland	IRL	Europe & Central Asia	High income	○	○	○	—
Italy	ITA	Europe & Central Asia	High income	○	○	○	—
Japan	JPN	East Asia & Pacific	High income	○	○	○	—
Korea, Rep.	KOR	East Asia & Pacific	High income	○	○	○	—
Netherlands	NLD	Europe & Central Asia	High income	○	○	○	—
Norway	NOR	Europe & Central Asia	High income	○	○	○	—
New Zealand	NZL	East Asia & Pacific	High income	○	○	○	—
Portugal	PRT	Europe & Central Asia	High income	○	○	○	—
Sweden	SWE	Europe & Central Asia	High income	○	○	○	—
United States	USA	North America	High income	○	○	○	—
<i>Additional 16 Countries</i>							
Egypt	EGY	Middle East & N. Africa	Lower-middle	—	○	—	—
India	IND	South Asia	Lower-middle	—	○	—	—
Sri Lanka	LKA	South Asia	Lower-middle	—	○	—	—
Malaysia	MYS	East Asia & Pacific	Upper-middle	—	○	—	○
Philippines	PHL	East Asia & Pacific	Lower-middle	—	○	—	○
Singapore	SGP	East Asia & Pacific	High income	—	○	—	○
Thailand	THA	East Asia & Pacific	Upper-middle	—	○	—	○
South Africa	ZAF	Sub-Saharan Africa	Upper-middle	—	○	—	—
Côte d'Ivoire	CIV	Sub-Saharan Africa	Lower-middle	—	—	—	—
Colombia	COL	Latin America & Carib.	Upper-middle	—	—	○	—
Honduras	HND	Latin America & Carib.	Lower-middle	—	—	—	—
Luxembourg	LUX	Europe & Central Asia	High income	—	—	○	—
Morocco	MAR	Middle East & N. Africa	Lower-middle	—	—	—	—
Malta	MLT	Middle East & N. Africa	High income	—	—	—	—
El Salvador	SLV	Latin America & Carib.	Lower-middle	—	—	—	—
Trinidad & Tobago	TTO	Latin America & Carib.	High income	—	—	—	—

Notes: Sample JT consists of the same 22 countries as Juselius and Takats (2021). Sample CF consists of 30 countries

for which expected inflation data from Consensus Forecast are available.

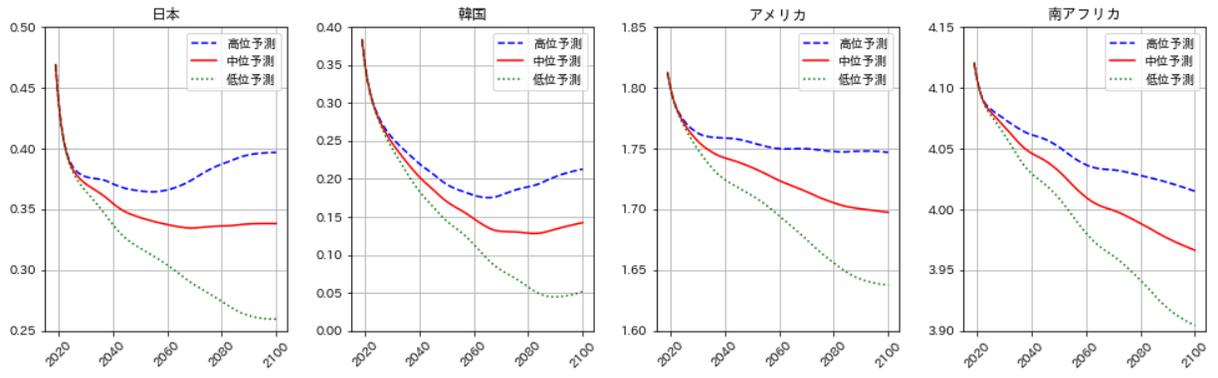


Figure A1: Very-Long-Run Inflation Trend Projections. *Notes:* From left: Japan, Korea, United States, South Africa. Based on equation (30) with individual effects. UN WPP2022 variants: high (blue dashed), medium (red solid), low (green dotted).