Rebalancing Housing Taxes for an Aging Economy

(Preliminary Draft)

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Abstract

This paper quantifies how the composition of real-estate taxation—property (stock) versus transaction (flow) taxes—affects macroeconomic performance and fiscal sustainability in an aging economy. Using a calibrated OLG-DSGE model with a construction sector, I find three results. First, transaction taxes distort trade and generate volatile revenue. Second, shifting toward property taxation broadens the base and stabilizes fiscal balances. Third, demographic aging erodes the transaction-tax base, amplifying fiscal risks. The framework provides a tractable tool for fiscal projections and tax-mix redesign tailored to Korean institutions.

Keywords: Housing taxes, Aging, OLG-DSGE, Laffer curves, Fiscal sustainability

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1. Introduction

How should an economy with rapid demographic aging design real-estate taxation to stabilize revenues and preserve fiscal sustainability? In Korea, real-estate related receipts surged during the most recent housing boom, with total real-estate revenues rising from 59.2 trillion KRW in 2017 to 108.3 trillion KRW in 2021, and their share in total central-government revenues climbing from 22% to 31% (National Tax Service of Korea, 2025). At the same time, the tax mix relies heavily on transaction-based instruments (acquisition and capital-gains taxes) and less on recurrent property taxation relative to countries such as the United States and the United Kingdom (Organisation for Economic Co-operation and Development, 2024). These institutional features expose the public purse to housing-cycle volatility via price and turnover, and they raise a broader question of tax design: whether shifting from taxing "turnover" to taxing "tenure" can deliver more resilient revenues and higher long-run output.

This paper develops a quantitative overlapping-generations DSGE model (OLG-DSGE) that embeds an explicit housing sector and a rich fiscal block to evaluate the macro-fiscal consequences of Korea's real-estate tax composition. Housing is a durable consumption good that provides utility services and interacts with a construction sector. The government levies standard labor and capital income taxes alongside two distinct real-estate instruments: a recurrent property (stock) tax on holdings and a transaction (flow) tax on new purchases; it can also issue domestic public debt. The model is calibrated to Korean institutions and moments, including the level and composition of real-estate revenues, the relative magnitudes of property, transaction, and capital-gains taxes, and empirical measures of housing turnover and prices. Demographic dynamics are treated as first-order: the baseline transition takes the 2019 pre-pandemic economy as a calibration point and projects macro-fiscal paths over 2025–2070 using statistical projections for the working-age population (Statistics Korea, 2021).

Two considerations motivate the analysis. First, Korea's tax structure places relatively large weight on transaction and capital-gains taxation, while recurrent property taxation—though higher than the OECD average as a share of GDP—remains markedly below levels in some advanced peers (Park, Jinbaek et al., 2023; Park, Hoon et al., 2025). Such a composition makes revenues more sensitive to asset-price cycles and residential mobility. Second, demographic aging reduces household mobility and trading frequency, mechanically squeezing the transaction-tax base even for unchanged statutory rates (Kim, Jiwoon and Hur, Jinwook, 2023). Both channels threaten fiscal stability when housing cycles turn or when aging accelerates. A proper assessment requires a general-equilibrium lens that marries the household portfolio and tenure margin with production, construction, and the government's intertemporal budget constraint.

Methodologically, the paper contributes by integrating a housing-augmented OLG-DGE with a granular fiscal block that separates stock versus flow taxation in real estate. This separation is essential because the two instruments operate through distinct margins: the property tax distorts holdings and wealth composition, while the transaction tax distorts mobility and reallocations, effectively imposing a wedge on trades and reducing the matching of houses to heterogeneous household needs. The model is solved for both steady states and perfect-foresight transitions under alternative tax schedules and demographic paths. The output includes (i) Laffer curves for labor, capital, and the two real-estate instruments; (ii) revenue and primary-balance responses around the calibrated steady state; and (iii) long-horizon debt dynamics under policy reforms and demographic scenarios (Hur, 2023).

The quantitative results can be summarized as follows. *First*, transaction taxes are highly distortionary at empirically relevant elasticities: by depressing mutually beneficial trades, they lower output and make revenues procyclical and volatile. *Second*, revenue-neutral shifts that lower the transaction tax and raise the recurrent property tax broaden the effective base, reallocate resources from speculative turnover to productive capital formation, and stabilize the primary balance; in steady-state experiments, increasing the property-tax rate delivers markedly larger revenue gains than equivalently scaled increases in the transaction-tax rate (Woo, Jinhee, 2022). *Third*, demographic aging erodes transaction-based revenues through lower mobility; absent rebalancing toward property taxation, debt-to-GDP ratios drift upward along the transition even when statutory rates are unchanged (D'Erasmo et al., 2016).

From a policy perspective, the findings provide a transparent mapping between instruments and outcomes. If the objective is *revenue resilience*, a greater emphasis on recurrent property taxation—anchored in assessed values and less tied to short-run trading volumes—outperforms transaction-based levies. If the objective is *growth and allocative efficiency*, reducing turnover wedges facilitates better house–household matches and attenuates misallocation between construction and non-housing production. Importantly, these gains are not mutually exclusive: a revenue-neutral tax-mix swap can raise output and deliver a more stable primary balance, improving long-term debt dynamics without mechanically tightening other major tax rates.

This paper also relates to the literature on fiscal design and sustainability in general equilibrium. Prior DSGE-based assessments have analyzed fiscal space, tax Laffer curves, and spending rules in representative-agent environments and, more recently, with demographic structures (Leeper, 1991; Trabandt and Uhlig, 2011; Auray et al., 2013; Hur, 2023). Housing has been brought into New Keynesian and OLG frameworks primarily to study collateral constraints, monetary transmission, and durability (Iacoviello, 2005; Bernanke and Gertler, 1989; Gertler and Karadi, 2011). This paper bridges the two strands by endogenizing real-estate tax composition in a housing-augmented OLG model with explicit demographic transitions, and by using it for long-horizon fiscal projections tailor-made to Korean institutions.

The remainder of the paper proceeds as follows. Section 2 documents the institutional context and stylized facts on the level, volatility, and composition of Korea's real-estate revenues in international comparison. Section 3 presents the model. Section 4 reports steady-state Laffer curves and transition experiments under alternative tax mixes and demographic scenarios. Section 5 concludes.

2. Institutional Background

2.1. Structure of Korea's Real-Estate Taxation

Korea's real-estate taxation framework comprises both national and local taxes. National taxes include the capital-gains tax, inheritance and gift taxes, and the comprehensive real-estate holding tax, while local governments collect property and acquisition taxes. Together these account for roughly one-fifth of aggregate tax revenues during normal periods, although the composition differs sharply from that in advanced OECD economies. Within the national component, the capital-gains and acquisition taxes dominate, whereas the property tax represents a smaller share. In local finances, the acquisition tax is the single largest item, exceeding the property tax both in absolute yield and in cyclical sensitivity. This composition reflects Korea's long-standing emphasis on taxing housing transactions and transfers rather than wealth or tenure.

During the housing boom of 2017–2021, real-estate related revenues surged from 59.2 trillion KRW to 108.3 trillion KRW, increasing from 22% to 31% of total central-government revenue. The surge was driven primarily by transaction-based receipts, especially acquisition and transfer taxes, which rose with turnover and prices. Since 2022, however, as housing transactions fell from 1.01 million to 0.64 million annually, these revenues have declined accordingly, illustrating their procyclicality. The heavy reliance on transaction-based taxes therefore amplifies fiscal exposure to housing-market cycles.

2.2. International Comparison of Revenue Composition

According to the Organisation for Economic Co-operation and Development (2024)[1], Korea's property tax revenue averaged around 3.0% of total tax revenue between 2017 and 2021, compared with 9–12% in the United States and the United Kingdom, 5–7% in Japan and France, and about 1% in Germany. Conversely, Korea's taxes on financial and capital transactions averaged roughly 7–9% of total tax revenue, far exceeding the OECD mean of 1–2%. The capital-gains tax on individuals averaged nearly 3%, also above the OECD mean of about 0.4%. Thus, while property taxation in Korea remains modest relative to OECD peers, transaction and transfer taxes are several times larger. These differences underscore Korea's distinctive tax-mix structure that emphasizes turnover over tenure.

2.3. Fiscal Implications

Such a composition has two critical implications for fiscal stability. First, revenues based on transactions fluctuate with housing-market cycles, introducing procyclicality into fiscal balances. During booms, revenues expand rapidly, but they contract sharply during downturns, weakening fiscal sustainability. Second, demographic aging is expected to further suppress housing transactions. Research by the Korea Land and Housing Institute and the Korea Institute of Public Finance projects declining mobility and "move-up" demand as the population ages and fertility rates remain low. By 2050, the working-age population will have fallen by roughly one-third, implying lower turnover and a narrower transaction-tax base. In contrast, recurrent property taxation provides a more stable base, being tied to assessed values rather than transaction frequency.

Simulations using demographic and macroeconomic projections from Statistics Korea (2021) suggest that a gradual rebalancing from transaction to property taxation can stabilize

[1] Categories follow the OECD Revenue Statistics taxonomy (4000 property taxes; 4400 financial & capital transactions). Source: Organisation for Economic Co-operation and Development (2024).

revenue volatility and support debt sustainability. Moreover, higher property-tax reliance can improve allocative efficiency: as real-estate prices stabilize, capital previously locked in speculative assets can be reallocated to productive sectors, potentially expanding the tax base through higher output and employment (Kim, Jiwoon and Hur, Jinwook, 2023; Woo, Jinhee, 2022).

In summary, Korea's real-estate tax system remains heavily tilted toward transaction-based instruments compared with its OECD peers. While this structure generated large short-run windfalls during recent housing booms, it also increases fiscal vulnerability to demographic and cyclical shocks. These empirical regularities motivate the quantitative analysis that follows, which embeds the institutional features of Korea's real-estate taxation within a dynamic general equilibrium framework to assess their macro-fiscal consequences.

3. Model Setup

The economy consists of households, two competitive production sectors (final goods and residential construction), and a government that levies standard taxes and issues one-period domestic bonds. Real estate is taxed via two distinct instruments: a recurrent *stock* tax on the market value of owned dwellings and a *flow* tax on the market value of newly purchased dwellings. Capital and labor are perfectly mobile across sectors; prices are competitive.

Demographics and sectors. At each date t, a young cohort of measure $\lambda_t \in (0, 1)$ and an old cohort of measure $1 - \lambda_t$ are alive. The final-goods sector produces the numeraire, while the construction sector produces new residential structures sold at relative price $p_{h,t}$. The one-period risk-free government bond is priced at q_t and pays one unit of the final good at $t + 1$.

Fiscal instruments. The government levies a consumption tax τ_c, a labor income tax τ_ℓ, a capital income tax τ_k, a recurrent property (stock) tax τ_h^{stock} on $p_{h,t}$ times the owned housing stock, and a transaction (flow) tax τ_h^{flow} on $p_{h,t}$ times new housing purchases. Lump-sum transfers to young and old are e_t^y and e_t^o; firm profits from the two sectors are rebated as π_t^f and π_t^h.

3.1. Households

Young households choose non-durable consumption, hours in each sector, next-period assets (bonds and physical capital), housing purchases, and the utilization rate of installed capital. Old households consume and can adjust their housing. Housing is a durable good yielding services and depreciating physically.

Preferences Per-period felicity is non-separable in consumption, leisure and housing services, embedded in a CRRA aggregator. Lifetime utility is

$$\sum_{t=0}^{\infty} \beta^t \left[\lambda_t \, \frac{\left(c_t^y (1 - \ell_t^f - \ell_t^h)^a (\omega h_t^y)^\xi\right)^{1-\sigma}}{1-\sigma} \; + \; (1 - \lambda_t) \, \frac{\left(c_t^o (\omega h_t^o)^\xi\right)^{1-\sigma}}{1-\sigma} \right], \tag{1}$$

where $\beta \in (0, 1)$, $\sigma > 0$ is the curvature, $a > 0$ the leisure weight, $\omega > 0$ rescales housing services, and $\xi > 0$ governs curvature in housing services. The composite for the young multiplies consumption with leisure and housing services, matching the source specification.

Budget constraint and laws of motion Let x_t denote gross investment in physical capital, $i_{h,t}^y, i_{h,t}^o$ housing purchases by young and old, k_t beginning-of-period physical capital, $m_t \geq 1$ its utilization rate, and d_{t+1} one-period government bonds bought at t. Cohort housing stocks at the start of t are h_t^y (young) and h_t^o (old). Aggregating across cohorts, the per-capita resource constraint of the household sector is

$$
\begin{aligned}
&(1+\tau_c)\big(\lambda_t c_t^y + (1-\lambda_t)c_t^o\big) + x_t + (1+\tau_h^{\text{flow}})\, p_{h,t}\left(\lambda_t i_{h,t}^y + (1-\lambda_t) i_{h,t}^o\right) \\
&\quad + \tau_h^{\text{stock}}\, p_{h,t}\left(\lambda_t h_t^y + (1-\lambda_t) h_t^o\right) + (1+r_t)\, q_t\, d_{t+1} \\
&= \lambda_t(1-\tau_\ell)\big(w_t^f \ell_t^f + w_t^h \ell_t^h\big) + (1-\tau_k)\, r_t\, m_t k_t + \theta\, \tau_k\, \delta_k + d_t + \lambda_t e_t^y + (1-\lambda_t) e_t^o + \pi_t^f + \pi_t^h,
\end{aligned}
\tag{2}
$$

where w_t^f, w_t^h are sectoral wages and r_t is the rental rate of capital. The left-hand side collects uses (consumption inclusive of τ_c, physical and housing investment inclusive of τ_h^{flow}, the stock tax on owned dwellings, and bond purchases), while the right-hand side aggregates resources (after-tax labor and capital income, bond income d_t, transfers, and profits). The term $\theta\, \tau_k\, \delta_k$ nests the tax treatment of depreciation consistent with the source notes.

Physical capital evolves with utilization-dependent depreciation and quadratic adjustment costs:

$$
(1+\gamma)\, k_{t+1} = \big(1-\delta(m_t)\big) k_t + x_t - \phi(k_{t+1}, k_t, m_t), \qquad \delta(m_t) = \chi_0\, \frac{m_t^{\chi_1}}{\chi_1}, \tag{3}
$$

$$
\phi(k_{t+1}, k_t, m_t) = \frac{\eta}{2}\left[\frac{(1+\gamma)k_{t+1}}{k_t} - \big(1-\delta(m_t)\big) - z\right]^2 k_t,
$$

with population growth γ, adjustment slope $\eta > 0$, utilization parameters $\chi_0 > 0, \chi_1 > 1$, and normalization z for steady-state replacement. Residential housing accumulates as

$$
(1+\gamma)\, h_{t+1} = (1-\delta_h) h_t + i_{h,t}, \qquad \delta_h \in (0,1). \tag{4}
$$

Optimality conditions and interpretation Let $\pi_t > 0$ denote the Lagrange multiplier on (2). The first-order conditions (FOCs) clarify how each tax enters along distinct margins.

Intratemporal margins (consumption and labor). From (1)–(2), the FOCs for young and old consumption imply

$$
\left(c_t^y (1-\ell_t^f-\ell_t^h)^a (\omega h_t^y)^\xi\right)^{-\sigma} (1-\ell_t^f-\ell_t^h)^a (\omega h_t^y)^\xi = \pi_t(1+\tau_c), \tag{5}
$$

$$
\left(c_t^o (\omega h_t^o)^\xi\right)^{-\sigma} (\omega h_t^o)^\xi = \pi_t(1+\tau_c), \tag{6}
$$

so the composite marginal utility of a one-unit increase in c equals the tax-inclusive shadow value of resources. Sectoral labor supply for $s \in \{f, h\}$ satisfies

$$a\, c_t^y (1 - \ell_t^f - \ell_t^h)^{a-1} (\omega h_t^y)^{\xi} (c_t^y (1 - \ell_t^f - \ell_t^h)^a (\omega h_t^y)^{\xi})^{-\sigma} = \pi_t (1 - \tau_\ell)\, w_t^s, \tag{7}$$

i.e., the after-tax wage equals the marginal rate of substitution, adjusted for the non-separable leisure–housing composite.

Capital utilization and accumulation. The utilization FOC equates the after-tax rental rate to the marginal depreciation and adjustment-cost terms:

$$(1 - \tau_k)\, r_t = \chi_0\, m_t^{\chi_1 - 1} \left[1 + \eta \left(\frac{(1+\gamma) k_{t+1}}{k_t} - 1 + \frac{\chi_0}{\chi_1} m_t^{\chi_1} - z \right) \right]. \tag{8}$$

The Euler equation for physical capital balances the *marginal installation cost* of a unit of k_{t+1} (LHS) with its discounted *marginal payoff* (RHS)—rental income net of utilization–induced depreciation and the shadow effect of next period's adjustment:

$$\pi_t (1+\gamma) \left[1 + \eta \left(\frac{(1+\gamma) k_{t+1}}{k_t} - 1 + \frac{\chi_0}{\chi_1} m_t^{\chi_1} - z \right) \right] \tag{9}$$

$$= \beta \pi_{t+1} [(1 - \tau_k) r_{t+1} m_{t+1} + 1 - \delta(m_{t+1}) - \phi_{k_t}(k_{t+2}, k_{t+1}, m_{t+1})]\,, \tag{10}$$

where ϕ_{k_t} denotes the partial derivative of next period's adjustment cost with respect to k_{t+1}. To make (10) operational, define

$$s_t \equiv \frac{(1+\gamma) k_{t+1}}{k_t} - \big(1 - \delta(m_t)\big) - z, \qquad g_{t+1} \equiv \frac{(1+\gamma) k_{t+2}}{k_{t+1}} - \big(1 - \delta(m_{t+1})\big) - z,$$

so that the current adjustment cost is $\phi(k_{t+1}, k_t, m_t) = \frac{\eta}{2}\, s_t^2\, k_t$ and next period's cost is $\phi(k_{t+2}, k_{t+1}, m_{t+1}) = \frac{\eta}{2}\, g_{t+1}^2\, k_{t+1}$. Differentiating the latter with respect to k_{t+1} yields the explicit derivative

$$\phi_{k_t}(k_{t+2}, k_{t+1}, m_{t+1}) = \frac{\eta}{2} \left[g_{t+1}^2 - 2\, g_{t+1}\, \frac{(1+\gamma) k_{t+2}}{k_{t+1}} \right]. \tag{11}$$

Substituting (11) into (10) gives the fully expanded capital Euler:

$$\pi_t(1+\gamma)\big[1+\eta\, s_t\big] = \beta\,\pi_{t+1}\Big\{(1-\tau_k)r_{t+1}m_{t+1} + 1 - \delta(m_{t+1}) - \frac{\eta}{2}\Big[g_{t+1}^2 - 2\,g_{t+1}\,\frac{(1+\gamma)k_{t+2}}{k_{t+1}}\Big]\Big\}. \tag{12}$$

Equations (8)–(12) show that the installation wedge depends on utilization m_t (through $\delta(m_t) = \chi_0 m_t^{\chi_1}/\chi_1$) and on the adjustment gap s_t, while the shadow term in (12) internalizes how today's k_{t+1} affects tomorrow's adjustment gap g_{t+1} and installation scale $(1+\gamma)k_{t+2}/k_{t+1}$.

Housing decisions and tax mix. Let the marginal service values be

$$U^y_{h,t+1} = \xi\omega(\omega h^y_{t+1})^{\xi-1}\big(c^y_{t+1}(1-\ell^f_{t+1}-\ell^h_{t+1})^a(\omega h^y_{t+1})^\xi\big)^{-\sigma}, \tag{13}$$

$$U^o_{h,t+1} = \xi\omega(\omega h^o_{t+1})^{\xi-1}\big(c^o_{t+1}(\omega h^o_{t+1})^\xi\big)^{-\sigma}. \tag{14}$$

The Euler equations for next-period housing chosen by young and old are

$$\pi_t(1+\tau_h^{\text{flow}})\,p_{h,t}\,(1+\gamma)\lambda_t \tag{15}$$

$$= \beta\Big[\lambda_{t+1}U^y_{h,t+1} + \pi_{t+1}\lambda_{t+1}\big((1-\delta_h)p_{h,t+1} - \tau_h^{\text{stock}}p_{h,t+1}\big)\Big], \tag{16}$$

$$\pi_t(1+\tau_h^{\text{flow}})\,p_{h,t}\,(1+\gamma)(1-\lambda_t) \tag{17}$$

$$= \beta\Big[(1-\lambda_{t+1})U^o_{h,t+1} + \pi_{t+1}(1-\lambda_{t+1})\big((1-\delta_h)p_{h,t+1} - \tau_h^{\text{stock}}p_{h,t+1}\big)\Big]. \tag{18}$$

Equations (16)–(18) make the tax mix transparent: the transaction (flow) tax τ_h^{flow} multiplies the *current marginal acquisition cost* on the left, directly discouraging adjustments (mobility and new purchases), whereas the property (stock) tax τ_h^{stock} reduces the *after-tax continuation value* of carrying an undepreciated unit into the next period on the right. Hence the two instruments load on distinct margins—turnover vs. tenure.

Risk-free bond. Optimal bond choice satisfies the standard perfect-foresight Euler condition

$$\pi_t(1+\gamma)\,q_t = \beta\,\pi_{t+1}, \tag{19}$$

which pins down the intertemporal price of one unit delivered at $t+1$. Combining (19) with (5)–(6) yields the usual consumption-smoothing relation across cohorts.

3.2. Firms

Final-goods sector. A representative final-goods firm operates a constant-returns Cobb–Douglas technology

$$Y_t = (K_t^f)^{1-\alpha}(L_t^f)^{\alpha}, \tag{20}$$

and takes the capital rental rate r_t and wage w_t^f as given. Profits are

$$\Pi_t^f = (K_t^f)^{1-\alpha}(L_t^f)^{\alpha} - r_t K_t^f - w_t^f L_t^f. \tag{21}$$

Profit maximization implies marginal-product pricing:

$$w_t^f = \alpha \frac{Y_t}{L_t^f}, \qquad r_t = (1-\alpha)\frac{Y_t}{K_t^f}. \tag{22}$$

With constant returns and perfect competition, $\Pi_t^f = 0$ in equilibrium.

Residential construction sector. The construction sector produces new dwellings according to

$$I_t = (K_t^h)^{1-a_h}(L_t^h)^{a_h}, \tag{23}$$

which are sold at the relative housing price $p_{h,t}$ (in units of the final good). With sectoral rental r_t^h and wage w_t^h, profits are

$$\Pi_t^h = p_{h,t}\,(K_t^h)^{1-a_h}(L_t^h)^{a_h} - r_t^h K_t^h - w_t^h L_t^h. \tag{24}$$

First-order conditions yield

$$w_t^h = p_{h,t}\,a_h \frac{I_t}{L_t^h}, \qquad r_t^h = p_{h,t}\,(1-a_h)\frac{I_t}{K_t^h}. \tag{25}$$

Under CRS and perfect competition, $\Pi_t^h = 0$. Combining (23)–(25) gives the unit-cost representation of the housing price:

$$p_{h,t} = \frac{1}{A_h} \left(\frac{r_t^h}{1 - a_h} \right)^{1-a_h} \left(\frac{w_t^h}{a_h} \right)^{a_h}, \tag{26}$$

where $A_h > 0$ is the (optional) productivity normalization (set $A_h \equiv 1$ if (23) omits TFP).

Labor mobility. Labor is freely mobile across sectors each period; hence the competitive wage equalizes:

$$w_t^f = w_t^h \equiv w_t.$$

If the household problem was written with sectoral wages w_t^f, w_t^h, impose this equality in equilibrium.

Capital mobility and allocation friction. To allow for imperfect capital mobility—e.g., sector-specific adjustment costs or financial segmentation—we adopt the reduced-form rule from the slides that links the sectoral capital split to the rental differential:

$$\frac{K_t^h}{K_t^f} = A \left(\frac{r_t^h}{r_t} \right)^{\phi}, \tag{27}$$

with scale $A > 0$ and elasticity $\phi \geq 0$. When $\phi \to \infty$, rental equalization $r_t^h \approx r_t$ is approached (near-frictionless reallocation). When $\phi = 0$, the split is fixed at $K_t^h / K_t^f = A$ (complete segmentation). For intermediate ϕ, a higher r_t^h / r_t reallocates capital toward construction, raises I_t, and—through (26)—feeds back into $p_{h,t}$.

3.3. Government

Spending. The government finances aggregate purchases and household transfers and services maturing debt. Let μ_t denote the population (or scaling) factor converting per–capita items into aggregates. Total spending is the sum of aggregate consumption g_t, transfers to young and old (e_t^y, e_t^o), and the face value of maturing debt d_t^g:

$$\mu_t g_t + \mu_t\big(\lambda_t e_t^y + (1-\lambda_t)e_t^o\big) \; + \; d_t^g. \tag{28}$$

Revenues by instrument. Tax revenue consists of a consumption tax, a labor income tax, a capital income tax (with depreciation allowance), and the two real–estate instruments:

$$\begin{aligned}
T_t^c &= \tau_c\, \mu_t\big(\lambda_t c_t^y + (1-\lambda_t)c_t^o\big),\\
T_t^\ell &= \tau_\ell\, \mu_t\big(w_t^f \ell_t^f + w_t^h \ell_t^h\big),\\
T_t^k &= \tau_k\, \mu_t\big(r_t m_t k_t - \theta\, \delta_k\, k_t\big),\\
T_t^{\text{stock}} &= \tau_h^{\text{stock}}\, \mu_t\, p_{h,t}\, h_t,\\
T_t^{\text{flow}} &= \tau_h^{\text{flow}}\, \mu_t\, p_{h,t}\, i_{h,t}.
\end{aligned} \tag{29}$$

Here h_t is the aggregate housing stock and $i_{h,t}$ aggregate new residential acquisitions (equal to construction output in equilibrium).

Period budget constraint. Each period the government covers total spending with tax revenues and new bond issuance. With one–period bonds priced at q_t, the static budget constraint is

$$\mu_t\big(T_t^c + T_t^\ell + T_t^k + T_t^{\text{stock}} + T_t^{\text{flow}}\big) \; + \; (1+r_t^b)\, q_t\, d_{t+1}^g \; = \; \mu_t(g_t + \lambda_t e_t^y + (1-\lambda_t)e_t^o) \; + \; d_t^g, \tag{30}$$

where r_t^b is the period-t gross return notation used in the slides (when the bond is risk-free, $1/q_t = 1 + r_t^b$ in perfect foresight).

No-Ponzi condition and intertemporal budget. While short-run deficits can be financed by issuing debt, sustainability requires the standard No-Ponzi condition:

$$\lim_{T\to\infty} \left(\prod_{s=0}^{T-1} \frac{1}{(1+\gamma)\,(1/q_{t+s+1})} \right) d_{t+T+1}^g = 0. \tag{31}$$

Combining (30) with (31) yields the government intertemporal budget constraint (IBC):

$$d_t^g = \sum_{j=0}^{\infty} \left(\prod_{s=0}^{j-1} \frac{1}{(1+\gamma)\,(1/q_{t+s})} \right) pb_{t+j}, \tag{32}$$

i.e., today's debt equals the present value of future primary surpluses, discounted by population growth and the bond pricing kernel.

Primary balance. Define the period-t primary balance (surplus) as total tax revenues net of non-interest expenditures:

$$\begin{aligned} pb_t &\equiv \mu_t\big(T_t^c + T_t^\ell + T_t^k + T_t^{\text{stock}} + T_t^{\text{flow}}\big) \ - \ \mu_t\big(g_t + \lambda_t e_t^y + (1-\lambda_t)e_t^o\big) \\ &= \mu_t\Big[\tau_c\big(\lambda_t c_t^y + (1-\lambda_t)c_t^o\big) + \tau_\ell\big(w_t^f \ell_t^f + w_t^h \ell_t^h\big) + \tau_k\big(r_t m_t k_t - \theta\,\delta_k\,k_t\big) + \tau_h^{\text{stock}} p_{h,t} h_t + \tau_h^{\text{flow}} p_{h,t} i_{h,t}\Big] \\ &\quad - \mu_t\big(g_t + \lambda_t e_t^y + (1-\lambda_t)e_t^o\big). \end{aligned} \tag{33}$$

Substituting (33) into (32) provides the PV relation linking d_t^g to the stream of $\{pb_{t+j}\}_{j\geq 0}$ used later to evaluate fiscal reforms.

3.4. Market clearing and equilibrium

Labor markets. Young households supply labor to both sectors; with population-scaling μ_t, market clearing requires

$$\mu_t \ell_t^f = L_t^f, \qquad \mu_t \ell_t^h = L_t^h. \tag{34}$$

Capital market. Effective private capital supply equals the sum of sectoral demands. With utilization m_t,

$$\mu_t\, m_t k_t \ = \ K_t^f + K_t^h. \tag{35}$$

Goods (resource) constraint. Aggregate value added from the two sectors equals aggregate absorption: private consumption, gross physical investment (including utilization–dependent depreciation and adjustment costs), new residential investment, and government consumption. Using the sectoral technologies and (3)–(4),

$$Y_t + p_{h,t} I_t \;=\; C_t + X_t + p_{h,t} I_t + G_t, \tag{36}$$

which, written in components, is

$$\begin{aligned}(K_t^f)^{1-\alpha}(L_t^f)^{\alpha} + p_{h,t}(K_t^h)^{1-a_h}(L_t^h)^{a_h} = {}& \mu_t\big(\lambda_t c_t^y + (1-\lambda_t)c_t^o\big)\\ &+ \mu_t\Big((1+\gamma)k_{t+1} - (1-\delta(m_t))k_t + \phi(k_{t+1}, k_t, m_t)\Big)\\ &+ \mu_t\big(\lambda_t i_{h,t}^y + (1-\lambda_t)i_{h,t}^o\big) \;+\; \mu_t g_t.\end{aligned} \tag{37}$$

The equality in (37) explicitly shows that residential investment is *additional* absorption; newly produced dwellings are not used as intermediate inputs in the final-goods sector nor as public purchases other than G_t.

Housing market. New dwellings supplied by the construction sector equal cohort purchases in the same period:

$$I_t \;=\; \mu_t\big(\lambda_t i_{h,t}^y + (1-\lambda_t)i_{h,t}^o\big). \tag{38}$$

Thus residential supply always matches demand; produced dwellings cannot be used for non-housing consumption or for physical capital formation.

Bond market. One-period government bonds are held domestically by households; market clearing requires

$$\mu_t\, d_{t+1} = d_{t+1}^g. \tag{39}$$

Competitive equilibrium. Given exogenous sequences $\{\lambda_t, \mu_t, \Xi_t, g_t, e^y_t, e^o_t\}$ and policies $\{\tau_c, \tau_\ell, \tau_k, \tau_h^{\text{stock}}, \tau_h^{\text{flow}}\}$, a competitive equilibrium is a collection of allocations

$\{c^y_t, c^o_t, \ell^f_t, \ell^h_t, k_{t+1}, m_t, i^y_{h,t}, i^o_{h,t}, K^f_t, K^h_t, L^f_t, L^h_t, I_t, d_{t+1}\}_{t\geq 0}$

and prices $\{w^f_t, w^h_t, r_t, r^h_t, p_{h,t}, q_t\}_{t\geq 0}$ such that: (i) households optimize subject to their constraints and laws of motion ((2)–(4)) and the FOCs ((5)–(19)); (ii) firms optimize and satisfy zero-profit conditions ((22), (25)); (iii) the government budget constraint and solvency hold ((30)–(32)); and (iv) markets clear ((34)–(39)) together with the resource constraint (37).

3.5. Calibration

We calibrate a subset of parameters externally from the literature and institutional sources, and pin down the remainder using steady-state restrictions and macro-fiscal moments for Korea (mostly 2019 pre-pandemic). Demographics are taken from official long-run projections: μ_t denotes population scale and λ_t the working-age share (15–64) used in the household aggregator; both series are treated as exogenous paths in the transition analysis.

External assignments. Risk aversion is set to $\sigma = 2$ (D'Erasmo et al. 2016). The utility weight on leisure follows Mendoza and Tesar (1998), $a = 2.675$. Housing utility curvature is $\xi = 0.2$, and the housing taste shifter is normalized to $\omega = 1$. Labor income shares in value added are set to the Korean data: the final-goods sector $\alpha = 0.5173$ (PWT 10.01), and the construction sector uses the same share $a_h = 0.5173$. The population growth growth rate is $\gamma = 0.023$. Capital-adjustment and tax-depreciation parameters follow D'Erasmo et al. (2016) unless noted. Statutory tax rates come from Hur (2023) and administrative sources. Housing taxes are mapped to the model as a recurrent property (stock) tax and a transaction (flow) tax.

Table 1: Externally assigned parameters

Symbol	Value	Interpretation	Source
σ	2	Relative risk aversion	D'Erasmo et al. (2016)
a	2.675	Utility weight on leisure	Mendoza & Tesar (1998)
ξ	0.2	Curvature of housing services in utility	Literature standard
ω	1	Housing taste scale (normalization)	Normalization
α	0.5173	Labor income share (final-goods)	PWT 10.01, Korea 2019
a_h	0.5173	Labor income share (construction)	Set equal to α
γ	0.023	Population growth	See text
η	0.517	Capital adjustment-cost slope	D'Erasmo et al. (2016)
θ	0.25	Tax depreciation allowance parameter	D'Erasmo et al. (2016)
τ_c	0.1115	Consumption tax rate	Hur (2023)
τ_k	0.2322	Capital income tax rate	Hur (2023)
τ_ℓ	0.1630	Labor income tax rate	Hur (2023)
τ_h^{flow}	0.03	Housing *transaction* (flow) tax	Statutory acquisition tax
τ_h^{stock}	0.004	Housing *property* (stock) tax	Statutory property tax
δ_h	0.015	Depreciation rate of residential stock	Standard assumption

Targets and steady-state restrictions. We choose parameters governing government and intersectoral frictions to match macro-fiscal ratios and transfer patterns in 2019. Specifically, we target the investment share x/y, the capital-output ratio k/y, government consumption g/y, total revenue rev/y, debt d/y, the old-to-young per-capita transfer ratio e^o/e^y, and the relative scale of non-housing capital deployed in construction via the capital-allocation scale A.

Given the external assignments and targets above, the remaining quantities are fixed by steady-state relations. The depreciation rate consistent with national accounts is $\bar{\delta} = 0.0579$;

Table 2: Moments used in calibration (targets, 2019)

Moment	Value	Definition	Source
x/y	0.3268	Investment share of GDP	PWT 10.01 (Korea, 2019)
k/y	4.1958	Capital-output ratio	Korean data, 2019
g/y	0.1726	Government consumption share	PWT 10.01 (Korea, 2019)
rev/y	0.2458	General government revenue over GDP	MOEF (2019)
d/y	0.3640	Government debt-to-GDP	MOEF (2019 national accounts)
e^o/e^y	4.6970	Per-capita transfer (old)/(young)	KOSTAT & FSS (2019)
A	0.473	Capital-allocation scale in (27)	Housing vs. non-housing capital

the adjustment-function coefficients (χ_0, χ_1) follow the slides; the growth-adjusted discount factor is normalized to $\hat{\beta} = 1$ in the stationary transformation; z is the benchmark installation ratio; and the initial per-capita policy levels for government consumption and transfers are (g_0, e^o, e^y).

Table 3: Parameters pinned down by steady-state conditions

Symbol	Value	Interpretation	Source/Note
$\bar{\delta}$	0.0579	Book depreciation rate (national accounts)	D'Erasmo et al. (2016) mapping
χ_0	0.0963	Level coefficient in $\delta(m) = \chi_0 m^{\chi_1}/\chi_1$	steady-state
χ_1	1.6634	Elasticity of depreciation w.r.t. utilization	steady-state
$\hat{\beta}$	0.9805	Growth-adjusted discount factor	Normalization
z	0.0779	Benchmark installation ratio	Steady-state normalization
g_0	0.1277	Per-capita government spending (baseline)	From g/y and y scale
e^o	0.1431	Per-capita transfers (old), baseline level	From e^o/e^y target
e^y	0.0305	Per-capita transfers (young), baseline level	From e^o/e^y target

3.6. Implementable system

Combining household optimality, firm conditions, and market clearing yields the following block of equilibrium relationships that we use for calibration and transitions.

Inter-cohort consumption allocation. From the young/old intratemporal FOCs, the marginal-utility ratio condition is

$$\frac{\left(c_t^y(1-\ell_t^f-\ell_t^h)^a(\omega h_t^y)^\xi\right)^{-\sigma}(1-\ell_{t+1}^f-\ell_{t+1}^h)^a(\omega h_{t+1}^y)^\xi}{\left(c_{t+1}^o(\omega h_{t+1}^o)^\xi\right)^{-\sigma}(\omega h_{t+1}^o)^\xi}=1. \tag{28}$$

Labor supply (MRS = after-tax real wage). Using the young's FOCs for consumption and hours,

$$\frac{a\,c_t^y}{(1-\ell_t^f-\ell_t^h)}=\frac{(1-\tau_\ell)}{(1+\tau_c)}\,w_t, \tag{29}$$

where w_t is the competitive wage (equalized across sectors in equilibrium).

Cross-sector factor-allocation conditions. From firm FOCs in the two sectors,

$$\alpha\,\frac{Y_t}{L_t^f}\;=\;p_{h,t}\,\alpha_h\,\frac{I_t}{L_t^h}\qquad\text{and}\qquad(1-\alpha)\,\frac{Y_t}{K_t^f}\;=\;p_{h,t}(1-\alpha_h)\,\frac{I_t}{K_t^h}, \tag{30}$$

which equate the sectoral marginal products of labor and capital valued at the housing price.

Capital utilization. The utilization FOC equates the after-tax rental to the marginal depreciation/installation cost:

$$(1-\tau_k)\,r_t=\chi_0\,m_t^{\chi_1-1}\left[1+\eta\left(\frac{(1+\gamma)k_{t+1}}{k_t}-1+\frac{\chi_0}{\chi_1}m_t^{\chi_1}-z\right)\right]. \tag{31}$$

Capital Euler. Let $s_t\equiv\frac{(1+\gamma)k_{t+1}}{k_t}-\big(1-\delta(m_t)\big)-z$ and $g_{t+1}\equiv\frac{(1+\gamma)k_{t+2}}{k_{t+1}}-\big(1-\delta(m_{t+1})\big)-z$ with $\delta(m)=\chi_0 m^{\chi_1}/\chi_1$. Then, using the derivative of next period's adjustment cost,

$$\phi_{k_t}(k_{t+2},k_{t+1},m_{t+1})=\frac{\eta}{2}\left[g_{t+1}^2-2\,g_{t+1}\,\frac{(1+\gamma)k_{t+2}}{k_{t+1}}\right],$$

the Euler equation can be written as

$$\pi_t(1+\gamma)\,[1+\eta s_t] = \beta\,\pi_{t+1}\left\{(1-\tau_k)r_{t+1}m_{t+1} + 1 - \delta(m_{t+1}) - \frac{\eta}{2}\left[g_{t+1}^2 - 2\,g_{t+1}\frac{(1+\gamma)k_{t+2}}{k_{t+1}}\right]\right\}. \tag{32}$$

Housing Euler (young). The intertemporal choice for next period's housing held by the young is

$$\pi_t(1+\tau_h^{\text{flow}})\,p_{h,t}\,(1+\gamma)\lambda_t = \beta\Big[\lambda_{t+1}U_{h,t+1}^y + \pi_{t+1}\lambda_{t+1}\big((1-\delta_h)p_{h,t+1} - \tau_h^{\text{stock}}p_{h,t+1}\big)\Big], \tag{33}$$

with $U_{h,t+1}^y = \xi\omega(\omega h_{t+1}^y)^{\xi-1}\big(c_{t+1}^y(1-\ell_{t+1}^f-\ell_{t+1}^h)^a(\omega h_{t+1}^y)^\xi\big)^{-\sigma}$.

Housing Euler (old). Analogously for the old,

$$\pi_t(1+\tau_h^{\text{flow}})\,p_{h,t}\,(1+\gamma)(1-\lambda_t) = \beta\Big[(1-\lambda_{t+1})U_{h,t+1}^o + \pi_{t+1}(1-\lambda_{t+1})\big((1-\delta_h)p_{h,t+1} - \tau_h^{\text{stock}}p_{h,t+1}\big)\Big], \tag{34}$$

with $U_{h,t+1}^o = \xi\omega(\omega h_{t+1}^o)^{\xi-1}\big(c_{t+1}^o(\omega h_{t+1}^o)^\xi\big)^{-\sigma}$.

Final-goods resource constraint. Aggregate absorption in the numeraire good equals value added:

$$Y_t = \mu_t\big(\lambda_t c_t^y + (1-\lambda_t)c_t^o\big) + \mu_t X_t + \mu_t g_t, \tag{35}$$

where $X_t = (1+\gamma)k_{t+1} - (1-\delta(m_t))k_t + \phi(k_{t+1}, k_t, m_t)$ is gross physical investment inclusive of utilization-dependent depreciation and adjustment costs.

New-housing market clearing. New dwellings produced equal cohort purchases:

$$I_t = \mu_t\big(\lambda_t i_{h,t}^y + (1-\lambda_t)i_{h,t}^o\big). \tag{36}$$

4. Results

4.1. Laffer curves

This section documents steady-state Laffer curves for the four instruments—housing stock, housing flow, capital-income, and labor-income taxes—holding all but one rate fixed in each experiment and measuring fiscal yield as the present value of the primary balance relative to GDP, PB/Y (Figure 2). The solid blue line represents the benchmark without demographic change, and the red dashed line overlays the economy with demographic aging (declines in the working-age share and overall population).

In the no-aging benchmark, revenue can be raised at the margin by increasing every tax rate, but the magnitude differs sharply across instruments. The housing stock tax generates the largest and most robust gains: its Laffer curve is monotone and steep over the examined policy range (a). Raising $\tau_{h,stock}$ toward 15 percent increases PB/Y by roughly 0.9 percentage points of GDP. The mechanism is straightforward. The stock levy falls on an assessed-value base that is broad and comparatively insensitive to short-run adjustments, so the tax base remains stable as the rate rises, and the curve climbs steadily rather than peaking.

By contrast, the housing flow tax displays an almost linear yet very flat schedule (b). Even at a 30 percent rate, the improvement in PB/Y is only about 0.05 percentage points relative to the baseline. Because $\tau_{h,flow}$ loads directly on the marginal acquisition cost of new housing, it suppresses transactions—the tax base itself—and therefore delivers weak revenue efficiency. In the benchmark without aging, the level of PB/Y attained around the 30 percent region is on the order of four-tenths of a percent of GDP, but nearly all of that is the pre-existing base; the incremental gain from the higher rate is small.

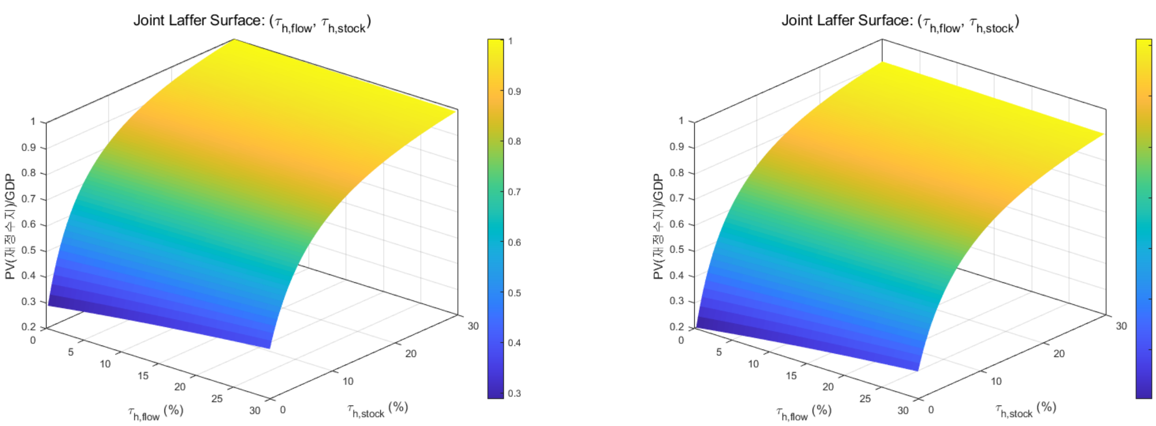
The income-tax instruments exhibit the conventional hump shape. For capital income, the revenue-maximizing rate lies near the low-30s in the benchmark (c). Beyond that point, the user cost of capital rises, installation and utilization decline, the capital stock contracts, and the base shrinks faster than the statutory rate increases. For labor income, the peak appears around the 60 percent region with a maximum PB/Y close to 1.2 percent of GDP (d). Further increases compress hours along both margins and eventually exhaust sectoral reallocation, so revenues fall past the summit.

Introducing demographic change uniformly worsens fiscal capacity. With aging, every Laffer curve shifts downward, and for the two income taxes the interior peak also shifts left. For capital income, the revenue-maximizing rate moves from roughly 30–35 percent in the benchmark to the neighborhood of the mid-20s when aging is imposed, and the maximal PB/Y decreases from about 0.45 percent of GDP to roughly 0.35 percent. The mechanism runs through a smaller effective workforce and slower accumulation, which erode the capital base and raise marginal excess burdens. For labor income, the peak migrates from the 60 percent range toward the 50s, while the maximal yield declines from about 1.2 percent to roughly 1.0 percent. Reduced effective labor input and dampened intensive-margin elasticities underlie this deterioration.

The housing taxes respond very differently to demographics. The stock tax remains comparatively stable: the curve in (a) shifts only modestly downward when aging is introduced, and the maximum declines just slightly (on the order of one-tenth of a percentage point of GDP over the considered range). This stability follows from the breadth and low cyclicality of the assessed-value base. In contrast, the flow tax is highly sensitive to demographics. Aging reduces mobility and turnover, shrinking the transactions base so that the entire schedule in (b) moves down materially; around the 30 percent region, the level of PB/Y settles closer to 0.35 percent rather than 0.45 percent, and the incremental gain relative to the baseline remains negligible. In short, taxing tenure is fiscally resilient, whereas taxing transactions is fiscally fragile.

Two policy implications follow. First, in an aging economy, relying more on the housing stock tax and less on the housing flow tax can stabilize revenues without pushing income-tax rates toward ranges where their Laffer curves are already on the downward-sloping side.

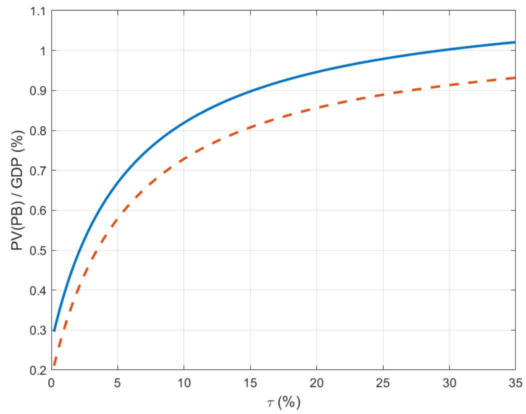
Second, while the stock tax dominates the flow tax on revenue grounds, neither instrument should be inferred to be costless on welfare or distributional margins. The stock levy and the flow levy both carry efficiency and incidence consequences: the former capitalizes into prices and burdens owners of high-value properties; the latter distorts mobility, reduces housing reallocation, and can worsen utilization of the existing stock. These considerations, together with equity and market-functioning objectives, imply that one cannot recommend setting housing-related tax rates to arbitrarily high levels simply because the stock schedule is monotone. Rather, the appropriate tax mix shifts weight from $\tau_{h,stock}, \tau_{h,flow}$ while acknowledging the welfare trade-offs, and it keeps income-tax rates below the post-aging revenue-maximizing ranges (mid-20s for capital, low-to-mid-50s for labor) to avoid eroding their tax bases.



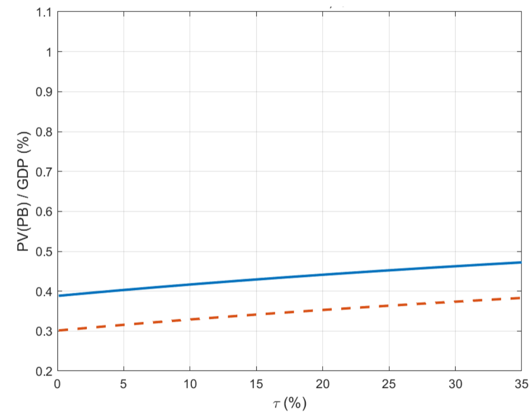
(a) Laffer curve : Non-demographic change

(b) Laffer curve : demographic change

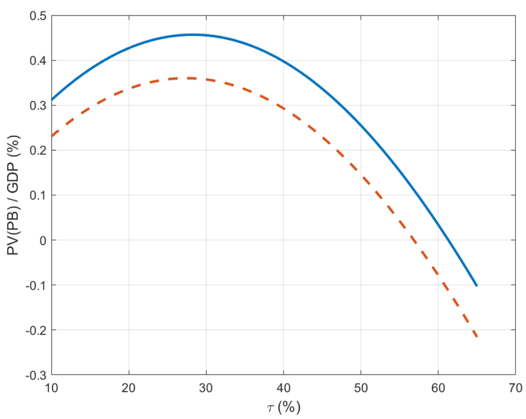
Figure 1: 3D Laffer surface (two–tax dimensions)



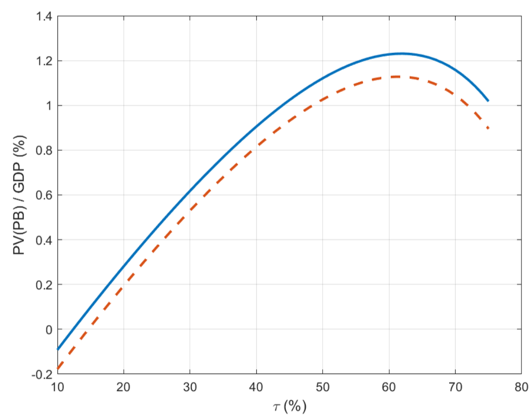
(a) Laffer curve: Housing stock tax



(b) Laffer curve: Housing transaction tax



(c) Laffer curve: Capital income tax



(d) Laffer curve: Labor income tax

Figure 2: Laffer curves for each tax type ($\tau_{h,stock}$, $\tau_{h,flow}$, τ_k, τ_l)

Note: Each panel plots the Laffer curve for a different tax instrument. The blue solid line represents the case without demographic changes (median-fertility scenario held constant), while the red dashed line represents the case with demographic changes (median-fertility transition).

4.2. Demographic steady states

Table 4 varies the population scale μ holding the working-age share λ fixed. The comparative statics are mild at the aggregate level: cohort consumption shares in GDP drift up gradually over the horizon for both the young and the old, and cohort new-housing purchases rise in tandem. The primary balance deteriorates only modestly—from a small surplus in the early 2020s to a small deficit by 2070—indicating that changes in sheer scale (with a stable age composition) do not by themselves destabilize the fiscal position. House prices display a slow upward drift (index values rising from the base of 100), consistent with a combination of steady construction costs and a broadly maintained tenure base. Overall, when composition is held constant, scale effects operate primarily through levels rather than through elasticities that would materially weaken the tax base.

Table 5 instead varies the working-age share λ holding population scale μ fixed. Here the fiscal effects are markedly stronger: the primary balance moves from a modest surplus to a sizable deficit over the horizon, reflecting the erosion of the tax base when effective labor supply shrinks and housing turnover declines. The house-price index trends downward, in line with weaker marginal demand from mobile cohorts and a smaller flow component in the user cost. On the demand side, the composition of spending tilts: the young's share in GDP rises while the old's share falls, and new-housing purchases become more concentrated on the young cohort even as total turnover slows. These patterns are consistent with the model's intratemporal labor condition and the housing Euler equations, where a lower λ reduces mobility and amplifies the adverse revenue effect of flow-based taxes relative to stock-based ones.

Table 6 combines the two forces by allowing μ and λ to move jointly along the demographic path. The fiscal impact is the largest in magnitude: the primary balance shifts from a small surplus into a pronounced deficit by the end of the sample, confirming that scale and composition effects reinforce each other when they co-move. New-housing purchases by both cohorts rise in level terms but are accompanied by a steady deterioration in PB/Y, highlighting that higher expenditure needs and a narrower, more cyclical tax base dominate on net. The house-price index drifts upward in this joint scenario, reflecting general-equilibrium price adjustments in construction costs and asset pricing that offset weaker turnover. Taken together, the three tables make clear that the working-age composition channel is first order for fiscal capacity, while pure scale changes are comparatively benign; when both operate, the pressure on the primary balance cumulates and underscores the case for shifting revenue weight from transaction to recurrent property taxation.

Table 4: Steady states under a change in population size μ (share of GDP unless noted)

Year	c_t^y/Y_t	c_t^o/Y_t	$i_{h,t}^y/Y_t$	$i_{h,t}^o/Y_t$	pb_t/Y_t	$p_{h,t}$
2020	0.480	0.332	3.074	2.127	0.034	100.000
2025	0.474	0.325	3.046	2.087	0.038	99.652
2030	0.470	0.320	3.026	2.058	0.040	99.409
2035	0.472	0.322	3.035	2.071	0.039	99.516
2040	0.478	0.330	3.064	2.113	0.035	99.876
2045	0.487	0.341	3.105	2.172	0.029	100.381
2050	0.499	0.356	3.163	2.256	0.021	101.078
2055	0.515	0.376	3.233	2.362	0.011	101.931
2060	0.532	0.398	3.310	2.479	0.000	102.844
2065	0.550	0.422	3.389	2.602	-0.011	103.771
2070	0.567	0.446	3.469	2.728	-0.023	104.696

Notes: c_t^y and c_t^o denote per-capita consumption of young and old cohorts; the first two columns report the cohort consumption components of aggregate consumption as a share of GDP. $i_{h,t}^y$ and $i_{h,t}^o$ are cohort demands for *new* housing; the third and fourth columns report $i_{h,t}^y$ and $i_{h,t}^o$ as % of GDP. pb_t is the primary-balance-to-GDP ratio. $p_{h,t}$ is the housing (new-dwelling) price index (2019=100). This scenario varies μ_t holding λ_t fixed.

Table 5: Steady states under a change in working-age share λ (share of GDP unless noted)

Year	c_t^y/Y_t	c_t^o/Y_t	$i_{h,t}^y/Y_t$	$i_{h,t}^o/Y_t$	pb_t/Y_t	$p_{h,t}$
2020	0.483	0.331	3.095	2.123	0.027	100.000
2025	0.488	0.330	3.130	2.116	0.015	99.814
2030	0.493	0.327	3.171	2.107	0.001	99.591
2035	0.499	0.325	3.220	2.096	-0.015	99.315
2040	0.505	0.322	3.268	2.084	-0.031	99.037
2045	0.510	0.320	3.310	2.073	-0.045	98.786
2050	0.515	0.317	3.346	2.063	-0.057	98.570
2055	0.518	0.316	3.371	2.056	-0.065	98.410
2060	0.523	0.313	3.415	2.043	-0.079	98.132
2065	0.528	0.310	3.458	2.030	-0.094	97.848
2070	0.530	0.309	3.478	2.023	-0.100	97.713

Notes: c_t^y and c_t^o denote per-capita consumption of young and old cohorts; the first two columns report the cohort consumption components of aggregate consumption as a share of GDP. $i_{h,t}^y$ and $i_{h,t}^o$ are cohort demands for *new* housing; the third and fourth columns report $i_{h,t}^y$ and $i_{h,t}^o$ as % of GDP. pb_t is the primary-balance-to-GDP ratio. $p_{h,t}$ is the housing (new-dwelling) price index (2019=100).

4.3. Property-stock tax increase scenario

We keep the model structure and parameter values from Section 3.5 unchanged. For each fertility (birth-rate) scenario, we track cohort consumption (young and old), cohort housing demand, capital, output, the primary balance PB/Y, and the house-price index. Along the experiment path, the recurrent property (stock) tax rate rises gradually—by 2% per year relative to the baseline—so that by 2070 the rate is twice its 2019 level; the baseline ("benchmark") keeps tax rates constant over the projection.

Table 6: Steady states under joint demographic change (μ, λ) (share of GDP unless noted)

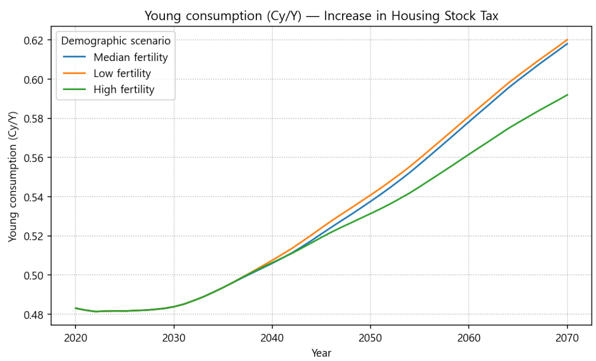
Year	c_t^y/Y_t	c_t^o/Y_t	$i_{h,t}^y/Y_t$	$i_{h,t}^o/Y_t$	pb_t/Y_t	$p_{h,t}$
2020	0.483	0.331	3.095	2.123	0.027	100.000
2025	0.482	0.322	3.102	2.075	0.019	99.459
2030	0.483	0.315	3.125	2.039	0.008	98.979
2035	0.491	0.314	3.183	2.040	-0.010	98.805
2040	0.503	0.319	3.259	2.069	-0.030	98.904
2045	0.517	0.328	3.339	2.118	-0.049	99.202
2050	0.533	0.341	3.426	2.193	-0.067	99.760
2055	0.552	0.360	3.514	2.292	-0.084	100.563
2060	0.573	0.379	3.622	2.398	-0.106	101.354
2065	0.594	0.400	3.728	2.510	-0.128	102.191
2070	0.613	0.424	3.810	2.633	-0.142	103.160

Notes: c_t^y and c_t^o denote per-capita consumption of young and old cohorts; the first two columns report the cohort consumption components of aggregate consumption as a share of GDP. $i_{h,t}^y$ and $i_{h,t}^o$ are cohort demands for *new* housing; the third and fourth columns report $i_{h,t}^y$ and $i_{h,t}^o$ as % of GDP. pb_t is the primary-balance-to-GDP ratio. $p_{h,t}$ is the housing (new-dwelling) price index (2019=100).

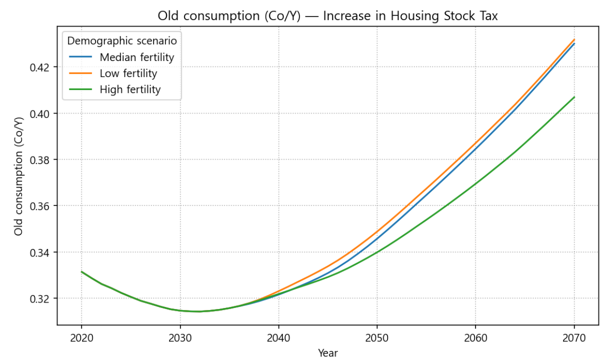
Under a higher stock-tax rate, the long-run paths of cohort consumption and housing demand evolve as follows. In panel (a), young consumption (as a share of GDP) rises from about 0.48 in 2020 to 0.63–0.64 by 2070 in the benchmark/low-fertility case, while in the high-fertility case it converges slightly lower, around 0.57–0.58. In panel (b), old consumption starts near 0.33 in 2020, dips around 2030, and then rises to 0.43–0.44 (benchmark/low) or 0.40–0.41 (high) by 2070. Panel (c) shows that young households' new-housing demand, roughly 3.1 of GDP in 2020, forms a trough near 2.85 around 2030 and then rises to 3.6 (benchmark/low) or 3.52 (high) by 2070. Finally, panel (d) indicates that old households' new-housing demand, about 2.1 of GDP in 2020, bottoms out near 2.1 around 2030 and then increases to 2.52 (benchmark/low) or 2.40–2.43 (high) by 2070.

Aggregate quantities and fiscal indicators move as follows. In panel (a), capital starts around 4.9 of GDP in 2020 and declines toward 3.4–3.6 by 2070; in the low-fertility case it falls to roughly 3.47, whereas in the high-fertility case it stabilizes near 3.6. Panel (b) shows that output falls from about 0.78 of GDP in 2020 to roughly 0.45–0.48 by 2070, with the largest decline under low fertility and a more moderate decline under high fertility. In panel (c), the primary balance remains higher than the baseline throughout the horizon and improves/stabilizes as the stock-tax rate rises, reflecting the broad and comparatively inelastic assessed-value base. This contrasts with transaction taxes, whose base shrinks with reduced turnover. Finally, panel (d) shows that the house-price index, normalized to 100 in 2020, declines to around 97.5 in the early 2030s and then recovers; by 2070 it is near 107 in the low-fertility scenario and around 110 in the high-fertility scenario.

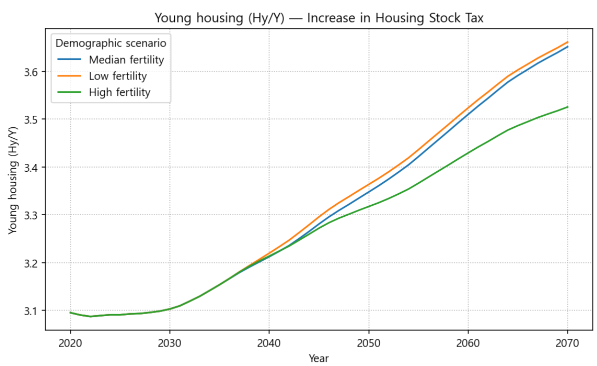
In summary, raising the property (stock) tax rate broadens a stable, assessed-value base and improves the fiscal primary balance (PB/Y) over the policy range considered, while leaving aggregate output close to its benchmark path. This stands in contrast to transaction taxes, whose base shrinks with reduced turnover—especially under aging—thereby delivering small and procyclical revenue gains.



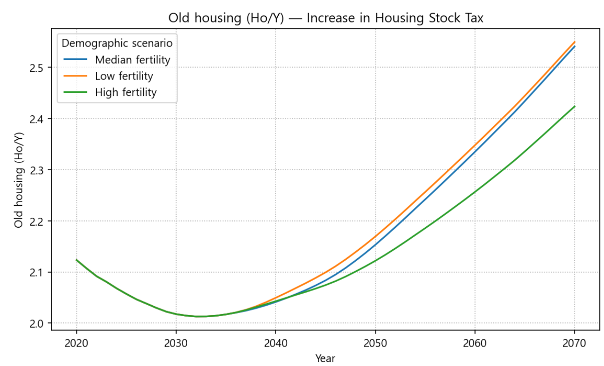
(a) Young consumption share in GDP



(b) Old consumption share in GDP



(c) Young households' new-housing demand / GDP



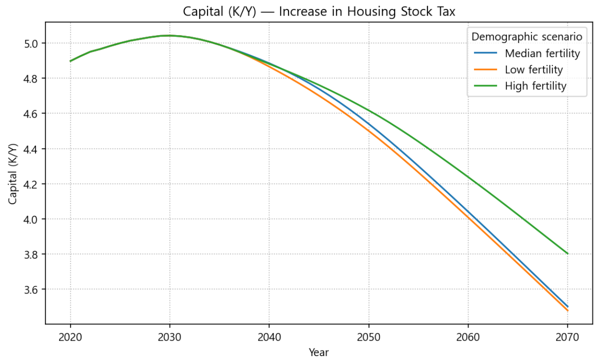
(d) Old households' new-housing demand / GDP

Figure 3: Cohort consumption and housing demand under a gradual increase in the property-stock tax

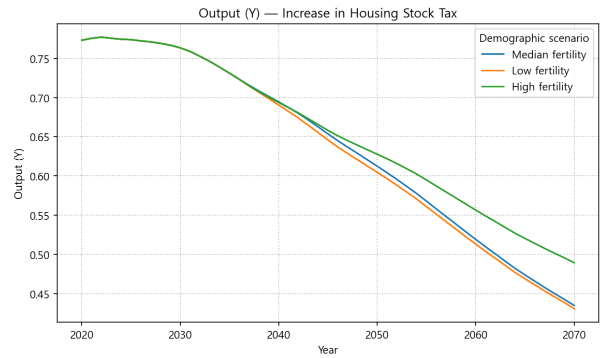
Note: Each panel plots the projected path under the stock-tax increase scenario (rate rises 2% per year relative to the 2019 baseline). The baseline path with constant tax rates is shown for comparison when available. Fertility scenarios (benchmark/low/high) follow the legend in each plot.

4.4. Transaction-tax increase scenario

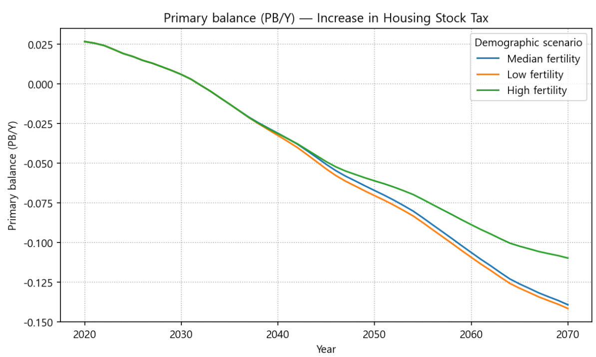
The model structure and parameters from Section 3.5 remain unchanged. In this experiment, the housing transaction (flow) tax rate rises gradually—by 2% per year relative to the baseline—so that by 2070 it reaches twice its 2019 level. The benchmark path keeps all tax rates fixed. For each fertility (birth-rate) scenario, we trace cohort consumption (young and old),



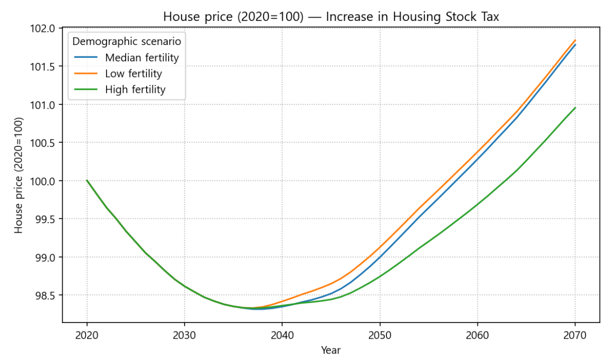
(a) Capital / GDP



(b) Output (index or share; see legend)



(c) Primary balance PB/Y



(d) House-price index ($2020 = 100$)

Figure 4: Aggregates, fiscal balance, and house prices under a gradual increase in the property-stock tax

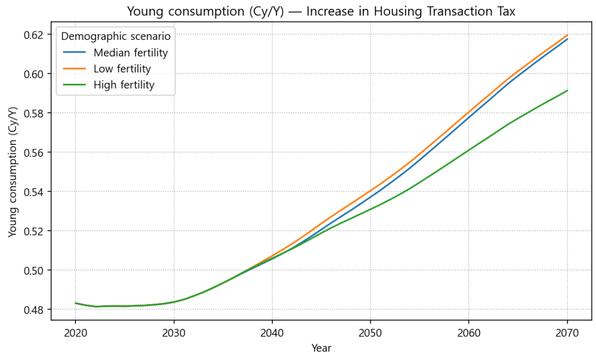
Note: The stock-tax rate increases gradually by 2% per year relative to the 2019 level; the baseline holds tax rates constant. Lines/markers follow the legend in each plot. Units: ratios are in GDP terms unless otherwise indicated (price index normalized to 100 in 2020).

housing demand, capital, output, the primary balance PB/Y, and the house-price index.

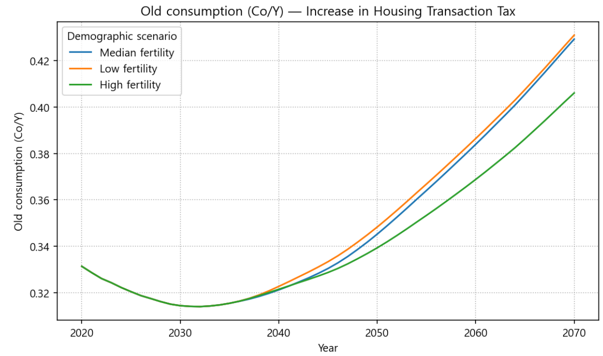
Figure 5 illustrates the evolution of cohort variables. In panel (a), the share of young households' consumption in GDP climbs steadily from about 0.48 in 2020 to around 0.61 by 2070; the low- and baseline-fertility cases show slightly higher paths, while the high-fertility case levels off near 0.59. Panel (b) reports that old households' consumption also rises, from roughly 0.33 in 2020 to between 0.42 and 0.44 by 2070, with smaller gains in the high-fertility case. Panel (c) depicts young households' new-housing investment: starting from about 3.1 of GDP, it first dips marginally and then increases to roughly 3.7–3.8 by the end of the horizon. Panel (d) shows a parallel expansion for old households, whose housing purchases grow from 2.1 of GDP in 2020 to around 2.6–2.7 by 2070, reflecting the larger population share of older cohorts in an aging economy.

Figure 6 presents the aggregate and fiscal outcomes. Panel (a) indicates that the capital stock gradually contracts—from roughly 4.9 times GDP in 2020 to about 3.5 by 2070—with a somewhat smaller decline under high fertility. In panel (b), output falls from around 0.78 of GDP to roughly 0.45–0.47, again with the mildest contraction in the high-fertility scenario. Panel (c) documents fiscal performance: the primary balance deteriorates from about 0.03 of GDP to a deficit of -0.12 to -0.14 by 2070, particularly under low fertility. Finally, panel (d) shows that the house-price index, normalized to $2019 = 100$, dips briefly to 98–99 in the early 2030s before recovering to about 103 (low fertility) or 105 (high fertility) by 2070.

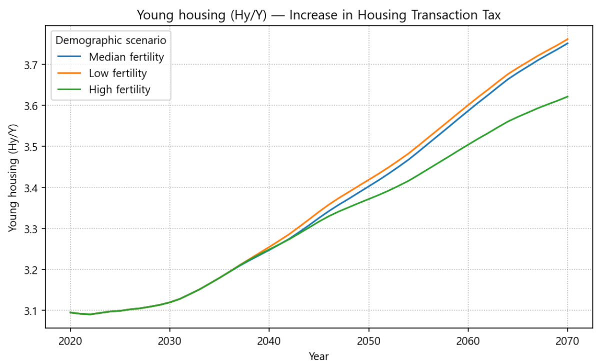
In summary, the gradual rise in the housing transaction tax depresses capital accumulation and output while worsening the fiscal position in all demographic settings. Nevertheless, higher fertility softens these adverse effects: the decline in productive capacity is smaller, the fiscal shortfall less severe, and the recovery in housing prices more pronounced. These results suggest that demographic strength helps offset the distortions induced by heavier transaction taxation, supporting a broader and more resilient tax base.



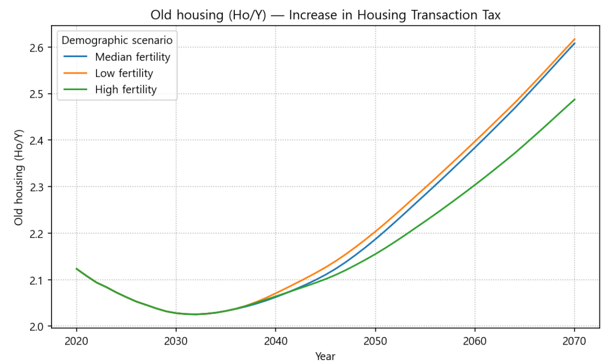
(a) Young consumption share in GDP



(b) Old consumption share in GDP



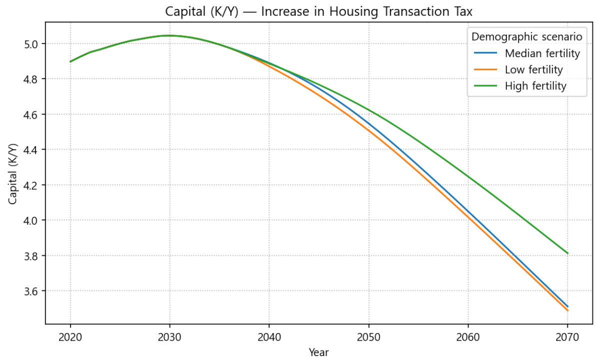
(c) Young households' new-housing demand / GDP



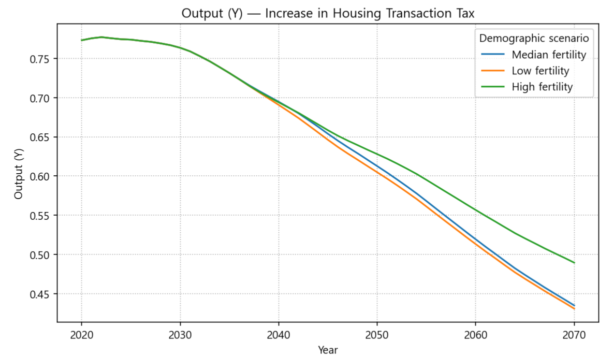
(d) Old households' new-housing demand / GDP

Figure 5: Cohort consumption and housing demand under a gradual increase in the housing transaction (flow) tax

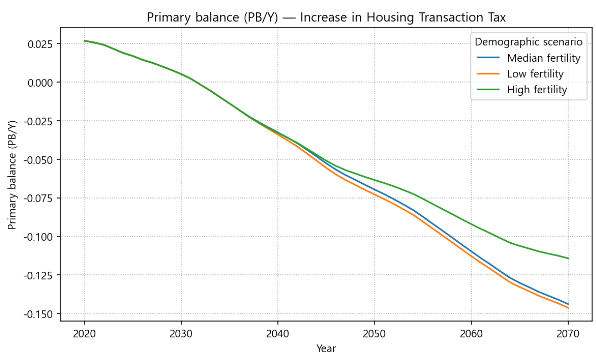
Note: Each panel plots the projected path under the transaction-tax increase scenario (rate rises 2% per year relative to the 2019 baseline). The baseline path keeps tax rates constant for comparison. Fertility scenarios (benchmark/low/high) follow the legend in each plot.



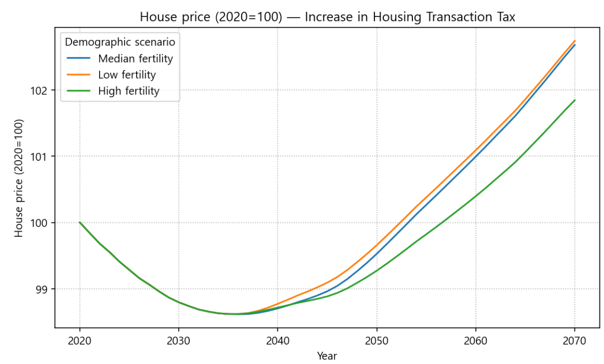
(a) Capital / GDP



(b) Output (index or share; see legend)



(c) Primary balance PB/Y



(d) House-price index (2019 = 100)

Figure 6: Aggregates, fiscal balance, and house prices under a gradual increase in the housing transaction (flow) tax

Note: The transaction-tax rate increases by 2% per year relative to its 2019 level. The baseline path keeps tax rates constant. Ratios are expressed in GDP terms unless otherwise indicated (price index normalized to 2019 = 100).

4.5. Comparison across tax-increase scenarios

Figure 8 summarizes the macro–fiscal effects of raising each major tax instrument under the median-fertility scenario, while Figure 7 presents the corresponding cohort-level outcomes. In all experiments except the benchmark, the relevant tax rate rises by 2

In panel (a), a gradual increase in the recurrent property (stock) tax markedly improves the primary balance PB/Y compared with the baseline while maintaining aggregate output close to its benchmark level. The revenue gain arises because the tax is levied on an assessed-value base that is broad and relatively inelastic, limiting behavioral distortions. Panel (b) shows that a higher housing transaction (flow) tax generates only marginal improvements in PB/Y since its base—new transactions—contracts when the rate rises. This self-limiting mechanism curtails revenue potential, leaving the overall fiscal impact small.

Panel (c) depicts the outcome of raising the labor-income tax. Although it strengthens the primary balance relative to the baseline, the improvement comes at the cost of a noticeable decline in output. The higher marginal tax wedge depresses both intensive and extensive labor margins, especially among younger cohorts whose net wage gains fall. Panel (d) shows the case of a higher capital-income tax: private capital accumulation declines sharply, reducing output and paradoxically worsening the fiscal balance relative to the baseline as the erosion of the tax base outweighs the higher statutory rate.

The two mixed housing-tax scenarios—raising the stock tax while lowering the flow tax, and vice versa—highlight interaction effects. Increasing the stock tax while easing the flow levy stabilizes revenue and output jointly: the broader base of the stock tax compensates for the smaller transaction base, yielding a smoother path for PB/Y and more moderate movements in the house-price index. The opposite mix, raising the flow tax and cutting the stock tax, produces the weakest fiscal outcome, as both the effective base and transaction volume shrink, limiting total revenue while modestly depressing prices.

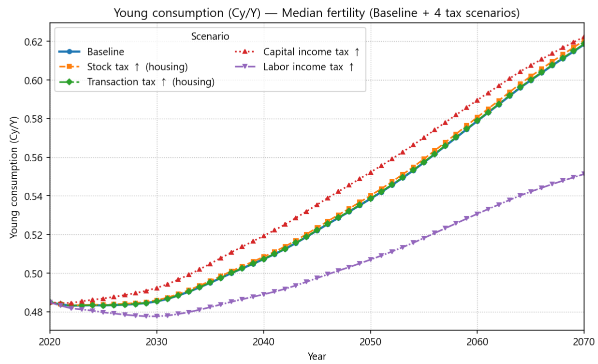
The underlying mechanism is straightforward. The stock tax, applied to accumulated assets rather than flows, does not directly distort production decisions in the goods or construction sectors. It primarily affects intertemporal housing demand rather than current output. By contrast, labor and capital taxes directly alter factor allocation: higher labor taxes reduce hours and participation, while higher capital taxes increase the user cost of capital and suppress investment. The transaction tax introduces a wedge in the turnover of housing assets, discouraging mobility and dampening construction activity. As a result, the stock tax stands out as the only instrument capable of raising the fiscal balance without a commensurate contraction in production.

Figure 7 details the cohort-level implications. In panel (a), young consumption follows broadly similar paths across tax scenarios but remains slightly higher under the stock-tax increase, where disposable income is less compressed. Panel (b) shows that old-age consumption rises gradually under all cases but is most stable when housing transaction taxes are low. Panels (c) and (d) report new-housing demand by cohort: both young and old households reduce purchases under higher flow-tax scenarios, reflecting the rise in transaction costs and a slower rate of reallocation across the housing stock.

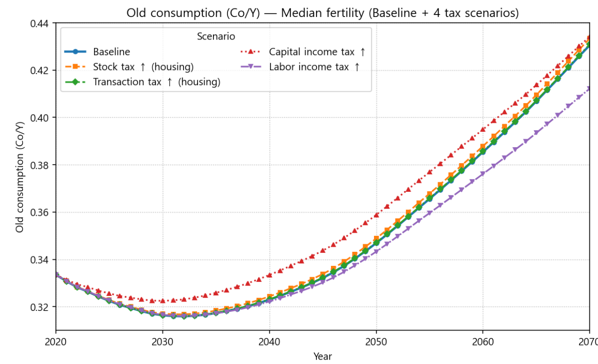
Taken together, these comparisons indicate that among all feasible revenue instruments, the recurrent property (stock) tax offers the most balanced trade-off between fiscal yield and macroeconomic efficiency. Capital- and labor-income taxes entail high output costs; transaction taxes generate weak revenues and sizable frictions. A tax mix that places greater weight on the stock component while moderating the flow levy can stabilize the fiscal path without undermining production or housing-market functioning.

Figure 9 compares the evolution of the property-tax share in total fiscal revenue across six policy experiments. All scenarios begin with a similar level—roughly two percent of total revenues in 2020—but diverge substantially over the projection horizon as differences in tax-base elasticities and incidence accumulate.

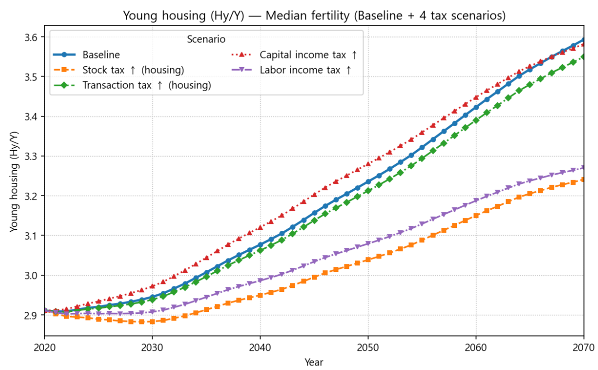
Under the property-tax-increase scenario, the share of property taxation rises steadily throughout the horizon, approaching about seven percent by 2070. This pattern reflects the broad and relatively inelastic nature of the property-tax base: since it is levied on the assessed value of the existing housing stock, the revenue expands proportionally with the rate while inducing little distortion in production or income generation. A comparable but slightly more moderate increase appears when the property tax rises in tandem with a reduction in the housing transaction tax, as the contraction in transaction distortions reinforces the stability



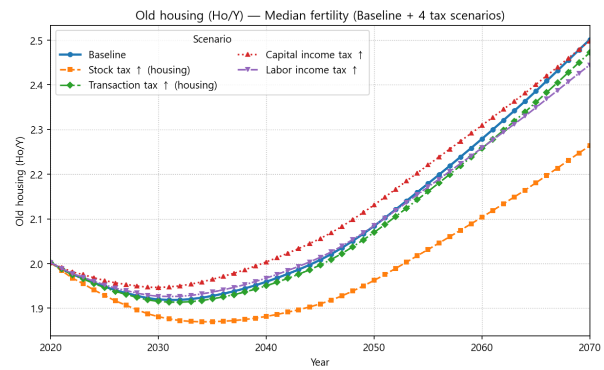
(a) Young consumption share in GDP



(b) Old consumption share in GDP



(c) Young households' new-housing demand / GDP



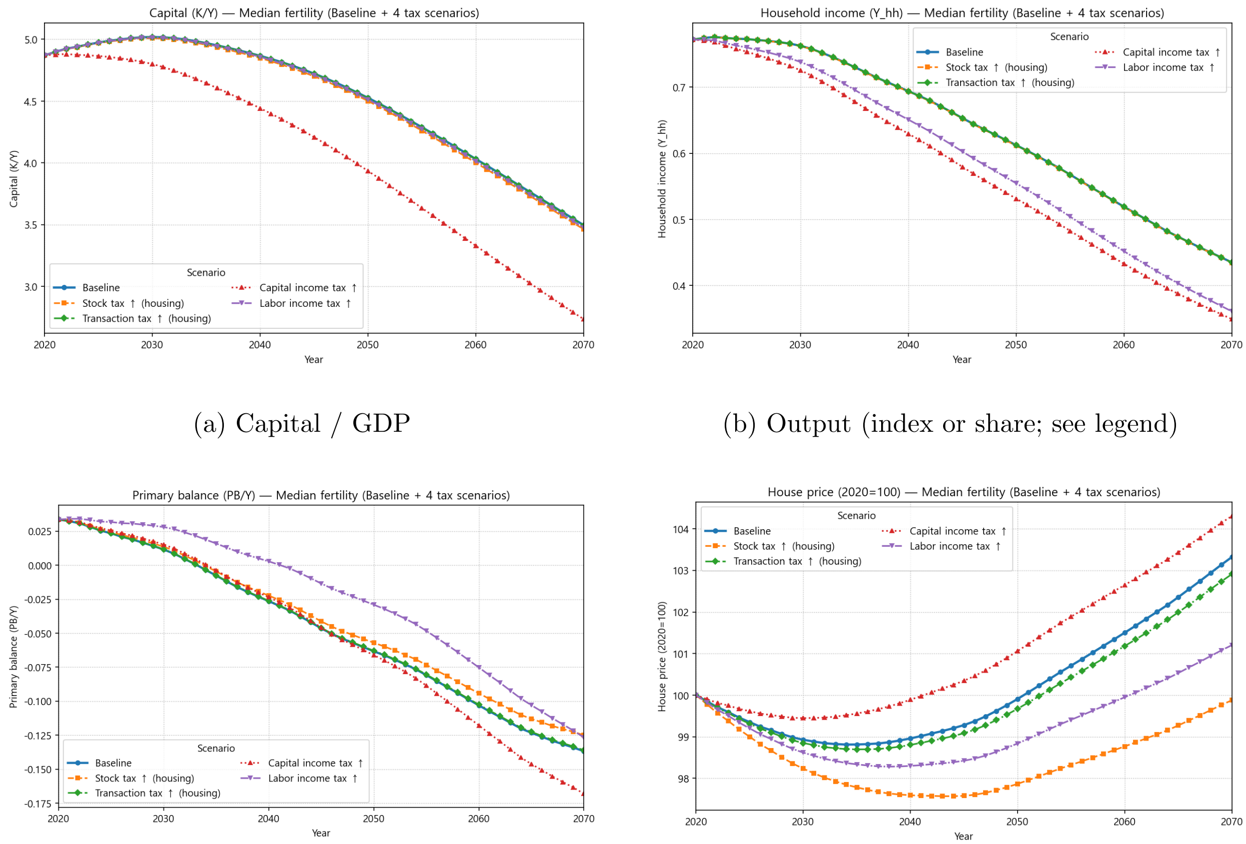
(d) Old households' new-housing demand / GDP

Figure 7: Cohort consumption and housing demand under six tax scenarios (median fertility)

Note: Median-fertility scenario only. Each panel compares six tax-policy paths: (1) capital-income tax, (2) labor-income tax, (3) housing stock (property) tax, (4) housing transaction (flow) tax, (5) stock-tax increase with flow-tax decrease, and (6) stock-tax decrease with flow-tax increase. Lines/markers follow the legend in each plot. Units: ratios are in GDP terms.

of the property-tax base.

By contrast, the transaction-tax-increase scenario yields only a modest rise in the property-tax share. Because the transaction tax directly suppresses housing turnover, the associated base shrinks as the rate increases, limiting any spillover into total revenue composition. When



(a) Capital / GDP

(b) Output (index or share; see legend)

(c) Primary balance PB/Y

(d) House-price index (base year per legend)

Figure 8: Aggregates, fiscal balance, and house prices under six tax scenarios (median fertility)

Note: Median-fertility scenario only. The six policy paths are: capital-income tax, labor-income tax, housing stock tax, housing transaction tax, stock-tax up with flow-tax down, and stock-tax down with flow-tax up. Ratios are GDP-normalized unless noted. The price index is normalized as indicated in the figure legend.

income taxes are raised—either on capital or labor—the property-tax share remains nearly constant or slightly declines. In these cases, the expansion of income-based revenues enlarges the denominator of total tax receipts, effectively diluting the relative weight of property taxation. Finally, when the transaction tax increases while the property tax is reduced, the share of the latter declines persistently and approaches zero by the end of the projection, reflecting a structural substitution between the two housing-related instruments.

Figure 9 demonstrates that taxes on stocks—such as recurrent property levies—provide a stable and gradually expanding fiscal base, whereas taxes on flows or factor incomes tend to erode their own bases through behavioral responses. A policy mix that relies more heavily on recurrent property taxation and less on transaction or income taxes thus enhances the long-term stability of the revenue composition without introducing significant production distortions.

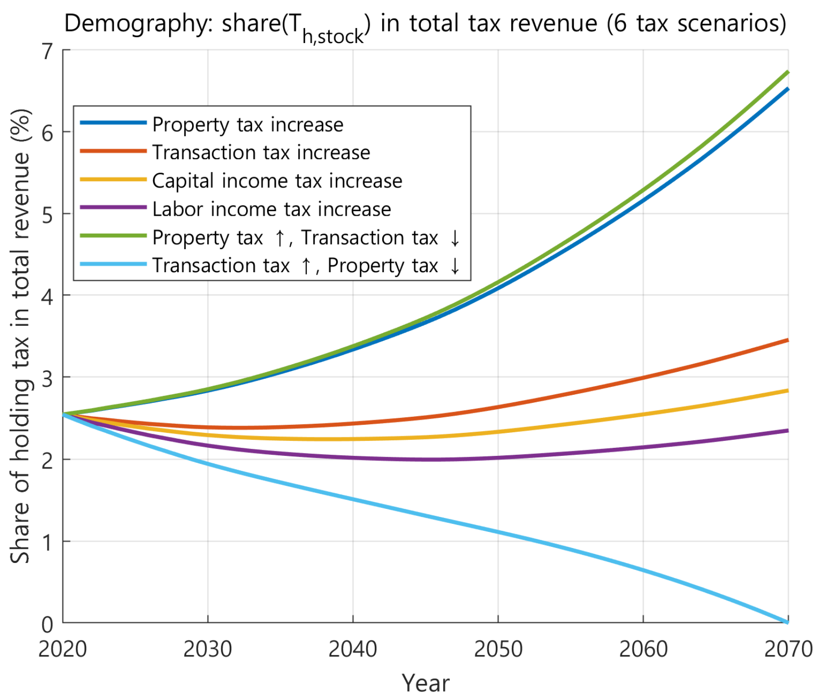


Figure 9: Share of property tax by demographic scenario

5. Conclusion

This paper built a housing-augmented OLG–DGE model to quantify how demographic change shapes medium- to long-run fiscal outcomes and to identify an efficient mix of real-estate taxes. By comparing scenarios that isolate a decline in the total population scale (μ) from a decline in the working-age share (λ), the analysis decomposes fiscal pressures and recovers instrument-specific priorities. The central finding is that the fall in λ is far more damaging for the primary balance than an equal fall in μ, because it compresses effective labor supply, investment, and the tax base simultaneously. On the tax side, recurrent property (stock) taxation has a markedly stronger and more stable revenue capacity than transaction (flow) taxation, and it dominates labor- and capital-income tax hikes that generate sizable output costs.

Three demographic experiments make these points precise. If only μ falls, aggregate demand and the tax base erode gradually and the primary balance deteriorates to about -1.4% of GDP by 2070. If only λ falls, the deterioration is much steeper as production capacity shrinks; the primary balance reaches roughly -9.3% of GDP by 2070. When both μ and λ fall, the effects compound and the primary balance approaches -13% of GDP by 2070. Taken together, these paths underscore that population aging operates primarily through the composition channel (λ) rather than the level channel (μ).

Laffer-curve experiments confirm that raising labor- or capital-income tax rates beyond their interior peaks lowers hours, utilization, and investment enough to reduce revenues relative to GDP. By contrast, the stock tax acts on tenure and a broad assessed-value base; revenues rise monotonically over the explored policy range and remain comparatively resilient under aging. The flow tax behaves very differently: because it loads on marginal acquisition costs and suppresses turnover—the base itself—its revenue effect is weak. Even when the transaction rate is lifted gradually to twice its initial level by 2070 (about a 30% statutory rate in our calibration), the improvement in the primary balance tops out at only about 0.55 percentage points of GDP. These contrasts imply that recurrent property taxation is the reliable instrument for revenue stabilization in an aging economy, whereas transaction taxation is not.

Policy implications. For medium-term consolidation that does not sacrifice aggregate production, priority should be given to strengthening the recurrent property (stock) tax. This instrument secures revenue on a broad, demographically robust base and continues to perform even as turnover declines with aging. The transaction (flow) tax should play only a supporting role: its base shrinks as mobility falls, so large statutory hikes translate into small and procyclical revenue gains. Income-tax increases should be used cautiously and remain near their Laffer peaks, since pushing rates higher trades away output for little net fiscal improvement.

Implementation should focus first on base broadening and administrative robustness of the stock tax—e.g., modernizing assessments and aligning assessed with market values—rather than abrupt rate jumps. Because higher stock taxes lower housing consumption for both young and old cohorts, distributional design (e.g., targeted reliefs or deferrals tied to liquidity constraints) is needed to preserve access to housing services while improving PB/Y. Importantly, reform should be evaluated across explicit fertility paths: a low-birth scenario magnifies capital and output contractions and weakens the transaction base, whereas a high-birth scenario attenuates these effects. Forward-looking rule design that conditions gradual stock-tax adjustments on medium-term fiscal needs is more resilient than one-off, across-the-board hikes.

Directions for future work. The present model treats demographic change as exogenous and abstracts from endogenous growth drivers. Extending the framework to allow for TFP and technology trends, labor-market reforms, and their interaction with housing would sharpen long-run projections. On the behavioral side, incorporating non-linear tax responses—avoidance, evasion, portfolio reallocation, and timing of transactions—would improve incidence and revenue mapping. Because the current analysis focuses on the central government, future work should embed intergovernmental fiscal relations (local revenue reliance on property and acquisition taxes, vertical sharing rules) to assess distributional and coordination issues. As mandatory outlays (pensions, health, long-term care) rise structurally, a unified treatment of spending commitments and revenue design is also needed. Finally, the perfect-foresight transition used here does not capture uncertainty or risk premia faced by the government; a stochastic transition analysis that embeds fiscal risk would provide a fuller view of sustainability under aging.

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