The Tax Cycle: Imperfect Indexation and Its Welfare Consequences*

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Abstract

When nominal incomes grow faster than the thresholds of a progressive tax system, households gradually face higher average and marginal tax rates even if statutory rates do not change. When the tax schedule is eventually adjusted, these rates fall. We refer to this recurring pattern as the *tax cycle*. Tax indexation—the adjustment of nominal tax-bracket thresholds to keep pace with prices or nominal incomes—shapes the extent of this cycle. We study its macroeconomic and welfare consequences in a heterogeneous-agent model. Across alternative indexation regimes, the government follows the same expenditure path and raises the same total revenue. Imperfect indexation lowers welfare by generating variation in effective marginal tax rates and weakening the tax base, which requires a higher overall tax burden to meet the common revenue requirement. The aggregate losses are moderate in the benchmark calibration but become larger when nominal income grows more rapidly, tax-schedule adjustments are less frequent, or the labor-income tax schedule is more progressive. Inflation indexation removes inflation-induced bracket creep but not the fiscal drag caused by real income growth. Welfare losses are larger for hand-to-mouth households, which have less ability to smooth the resulting fluctuations in disposable income.

Keywords: bracket creep, fiscal drag, tax indexation, tax smoothing, heterogeneous agents, welfare cost

JEL Classification: E62, H21, H24, E31, D31

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1 Introduction

Following the seminal work of Barro (1979), tax smoothing has served as a benchmark principle for the intertemporal design of fiscal policy. The central intuition is straightforward. If the welfare cost of distortionary taxation is convex, raising a given amount of revenue through a fluctuating sequence of tax rates is generally more costly than raising it through a smoother sequence. Higher effective marginal labor-income tax rates, for example, discourage labor supply and reduce taxable income. When government financing needs and other relevant economic fundamentals are stable, unnecessary variation in effective marginal tax rates therefore creates avoidable welfare losses.

This principle has played an important role in the modern optimal-taxation literature. Barro (1979) used it to explain why governments issue debt in response to temporary expenditure shocks rather than adjusting current tax rates one-for-one with government spending. In neoclassical growth models, the same logic underlies the optimal fiscal-policy results of Chari et al. (1994). Under appropriate conditions, the smoothing principle also extends to nonlinear and progressive taxation: redistribution across households need not require unnecessary variation over time in the marginal tax rates faced by a given type of worker (Werning, 2007). More broadly, government debt, state-contingent returns, and movements in the price level may allow fiscal shocks to be absorbed without large and abrupt changes in distortionary taxation (Leeper, 1991; Sims, 1994; Bianchi and Melosi, 2017; Bianchi et al., 2023; Bhattarai et al., 2023, 2026).

The tax-smoothing principle does not imply that efficient tax rates must always remain constant. Effective tax rates may appropriately change when government expenditures, redistributive objectives, taxable capacity, or other economic conditions change. Rather, tax smoothing provides a benchmark for identifying tax-rate variation that serves no corresponding fiscal or redistributive purpose. This paper studies an important institutional source of such mechanically induced variation.

Most modern income-tax systems are progressive and specify tax-bracket thresholds, deductions, exemptions, and other parameters in nominal units. When nominal taxable income grows because of inflation or real income growth, households move upward through a tax schedule whose nominal parameters may adjust more slowly than their incomes. Their effective average and marginal tax rates consequently increase even when statutory tax rates remain unchanged. This phenomenon is commonly described as bracket creep when driven by inflation and, more broadly, as fiscal drag when real income growth also contributes to the increase in effective tax rates.

Some countries automatically adjust nominal tax-bracket thresholds for inflation. Inflation indexation preserves the purchasing power of those thresholds and eliminates conventional inflation-induced bracket creep. It does not, however, prevent effective tax rates from rising as real incomes grow. Other countries have no general automatic indexation rule and instead rely on discretionary legislative amendments. In these systems, both inflation and real income growth can cause taxable income to rise relative to nominal tax-bracket thresholds.

Governments eventually revise their tax schedules, but such revisions are often partial, uneven, and infrequent. Effective tax rates may therefore rise while nominal income outpaces tax-bracket thresholds and fall when the thresholds are subsequently adjusted. We refer to this recurring sequence of rising and falling effective tax rates as a *tax cycle*. Unlike the tax-rate movements usually studied in the tax-smoothing literature, the tax cycle need not originate in a change in government expenditure or another fiscal shock. It can arise mechanically from imperfect indexation even when the underlying fiscal requirement and other economic fundamentals remain stable.

We study the macroeconomic and welfare consequences of this tax cycle in a heterogeneous-agent general-equilibrium model with incomplete markets (Aiyagari, 1994). Households face idiosyncratic labor-productivity risk and make consumption, saving, and labor-supply decisions. Labor income is taxed progressively. When trend nominal income grows faster than nominal tax-bracket thresholds, households gradually face higher effective average and

marginal tax rates. A subsequent adjustment of the tax schedule lowers those rates, after which the process begins again.

We compare three stylized indexation regimes. Under full nominal-income indexation (hereafter, full indexation), nominal tax-bracket thresholds grow with both the price level and trend real income. A household that remains at the same position in the income distribution therefore faces stable effective tax rates. Under inflation indexation, thresholds grow with the price level but not with trend real income, so real income growth continues to generate fiscal drag. Under no automatic indexation, nominal thresholds remain fixed between discretionary adjustments, allowing both inflation and trend real income growth to contribute to the tax cycle.

Under imperfect indexation—inflation indexation or no automatic indexation—the economy does not settle at the same detrended allocation in every period. Effective tax rates, labor supply, saving, capital, tax revenue, output, and the distribution of households instead vary systematically with the position within the tax cycle. Households anticipate this recurring pattern and adjust their decisions in response to future tax changes. We therefore characterize a periodic stationary equilibrium in which household decisions, prices, distributions, and government financial positions may differ across phases of the cycle but repeat after the tax schedule is adjusted. Under full indexation, all phases are identical and the periodic equilibrium collapses to an ordinary stationary equilibrium.

To isolate the economic consequences of the tax cycle, we compare indexation regimes under the *same* underlying fiscal requirement. In every regime, the government follows the same government-purchase path, raises the same total amount of tax revenue over the cycle, and holds fixed the progressivity of labor taxation and the capital-income tax rate. The government may borrow or save temporarily as tax revenue fluctuates within the cycle, but its financial position cannot drift across successive cycles. Thus, no regime can appear more attractive merely because it provides fewer public goods, raises less revenue, applies different tax parameters, or shifts a larger fiscal burden to the future. Welfare differences instead

reflect the timing and variation of effective tax rates and the resulting general-equilibrium responses.

The model highlights three channels through which the tax cycle induced by imperfect indexation lowers welfare. The first is the tax-variation channel, which reflects the classic welfare cost of imperfect tax smoothing. Consider a constant path of effective marginal tax rates and a fluctuating path with the same cycle-average tax level. When the welfare cost of distortionary taxation is convex, variation around a given average raises the average welfare cost. This channel therefore operates even when the overall level of effective tax rates is held fixed.

The second is the revenue-level channel. As effective marginal tax rates rise over the cycle, households reduce labor supply and taxable labor income. This tax-base feedback causes revenue to increase less than proportionally with the tax burden. As a result, for a given overall tax level, a fluctuating tax path raises less cycle-total revenue than a smoother path. Meeting the common revenue target therefore requires a higher overall level of effective average and marginal tax rates. The revenue-level channel is thus analytically distinct from, but closely related to, the tax-variation channel: the former operates through the adjustment in the overall tax level required by the endogenous response of the tax base.

The third is the limited self-insurance channel, which operates through incomplete markets. Households with sufficient asset buffers can use saving and dissaving to smooth consumption across the tax cycle. Households with little or no wealth have less capacity to self-insure, so fluctuations in disposable labor income pass more directly into consumption. The same tax cycle can therefore impose a larger welfare cost on hand-to-mouth households than on the economy as a whole.

We calibrate the model to the Korean economy. Korea provides a useful motivating case because it does not operate a general automatic indexation rule for personal-income-tax bracket thresholds. Its statutory rates and thresholds have been amended on several occasions, but the tax schedule has not been comprehensively rescaled in line with cumulative nominal

income growth. Several important lower and middle thresholds remained fixed for extended periods, while many reforms involved changes in top statutory rates or the introduction of additional upper-income brackets applying to a relatively small share of workers. These reforms were partial and uneven rather than equivalent to systematic indexation.

The model simulations show that imperfect indexation generates systematic within-cycle movements in effective average and marginal tax rates, labor supply, saving, capital, tax revenue, and output. Effective labor declines as the economy moves toward the later, higher-tax phases. Households accumulate assets early in the cycle and draw them down later, generating a hump-shaped capital path. Tax revenue rises at a diminishing rate as the contraction of the tax base increasingly offsets the direct effect of higher tax rates. Although output may initially exceed the full-indexation benchmark, the later losses dominate, leaving cycle-average output lower under imperfect indexation.

Quantitatively, aggregate output and welfare losses are moderate under our benchmark calibration but become larger when tax-schedule adjustments are less frequent, nominal income grows more rapidly relative to tax thresholds, or the labor-income tax schedule is more progressive. Inflation indexation removes the inflation-driven component of the tax cycle but not the fiscal drag from trend real income growth. Consumption and welfare losses are substantially larger for hand-to-mouth households than for the economy as a whole.

Our contribution is threefold. First, we identify imperfect indexation as an institutional source of recurring variation in effective tax rates that is not driven by changes in government expenditure or other fiscal fundamentals. Even in an otherwise stable environment, the interaction between nominal income growth and slowly adjusting tax-bracket thresholds generates a tax cycle. Second, we quantify the general-equilibrium and welfare consequences of this cycle while requiring the alternative indexation regimes to follow the same government-purchase path, raise the same total revenue, and prevent government assets or debt from drifting across cycles. Third, the heterogeneous-agent framework allows us to show how households' capacity for self-insurance shapes the welfare consequences of imperfect indexation.

Beyond the tax-smoothing literature discussed above, this paper is related to two additional strands of work. First, a large empirical and microsimulation literature measures the revenue and distributional consequences of bracket creep and fiscal drag. Earlier studies document hidden tax increases and redistributive effects in OECD countries and Germany (Heinemann, 2001; Zhu, 2014; Dorn et al., 2017). More recent work sharpens the measurement of these effects. Sanz-Sanz and Arrazola (2025) distinguish between the static and dynamic components of bracket creep. Using Spanish administrative tax records, Balladares and García-Miralles (2026) document substantial heterogeneity across the income distribution and across features of the tax code. García-Miralles et al. (2026) extend this analysis to 21 European countries, emphasizing cross-country differences in tax-to-base elasticities, underlying mechanisms, and policy offsets. Balasundharam et al. (2023) document international variation in indexation practices, while Garcia-Macia (2023) places fiscal drag within the broader effects of inflation on public finances.

Second, a smaller structural literature studies the macroeconomic consequences of tax indexation. Heer and Süssmuth (2013) analyze the long-run distributional effects of bracket creep in a heterogeneous-agent model; Keinsley (2016) examines its interaction with monetary and fiscal policy; and Hack (2025) studies inflation-induced bracket creep in an incomplete-markets economy. We complement these studies by interpreting imperfect indexation as a source of a recurring cycle in effective tax rates—the tax cycle—and connecting this institutional mechanism to the tax-smoothing benchmark. By holding government purchases, cycle-total tax revenue, and tax parameters fixed across regimes, while preventing government assets or debt from drifting across cycles, we isolate the welfare consequences of mechanically induced tax-rate variation. The heterogeneous-agent framework further allows us to examine how these consequences depend on households' ability to smooth consumption.

The remainder of the paper is organized as follows. Section 2 describes the main tax-indexation regimes and presents the institutional background. Section 3 develops the heterogeneous-agent model, introduces the tax-system parameterization, and defines the peri-

odic stationary equilibrium. Section 4 describes the calibration and presents the quantitative results. Section 5 concludes.

2 Institutional Background

2.1 Three indexation regimes

Tax systems differ not only in statutory rates but also in how nominal tax-bracket thresholds evolve. For the purposes of this paper, it is useful to distinguish three stylized regimes.

(i) **Full (nominal-income) indexation.** Nominal thresholds are adjusted in line with a measure of average nominal earnings. If household incomes grow proportionally with average nominal earnings, this keeps households' positions within the tax schedule unchanged.

(ii) **Inflation indexation.** Nominal thresholds are adjusted in line with a price index. This preserves their real value and eliminates conventional inflation-induced bracket creep, but real income growth continues to raise effective tax rates.

(iii) **No automatic indexation.** Nominal thresholds remain fixed until they are changed through discretionary legislation. Under a progressive tax schedule, both inflation and real income growth generate fiscal drag between adjustments.

Table 1 summarizes this stylized institutional classification. Actual tax systems rarely correspond exactly to any one of these regimes. Countries may index only selected thresholds, use lagged inflation, apply caps or floors, or temporarily suspend an otherwise automatic rule. The economically relevant object is therefore not the legal label alone but the growth rate of the nominal tax schedule relative to taxable income.

Table 1: Stylized classification of tax-bracket indexation in OECD countries

Category	Countries
Full indexation	Czech Republic, Denmark, Finland, Sweden[a] (4 countries)
Inflation indexation	Austria, Belgium, Canada, Chile, Colombia, Costa Rica, France, Israel, Mexico[b], Netherlands, Norway, Slovakia, Switzerland, Türkiye, United Kingdom[c], USA (16 countries)
No indexation	Australia, Estonia, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, New Zealand, Poland, Portugal, Slovenia, Spain (18 countries)

Source: Authors' compilation based on OECD (2023), Beer et al. (2023, IMF Working Paper 23/18, Table 1), and national tax legislation as of January 2026.
[a] Sweden's tax threshold is indexed at CPI plus 2 percentage points.
[b] In Mexico, income tax brackets are adjusted when cumulative CPI inflation since the last update exceeds 10%.
[c] The UK has an automatic indexation scheme for tax brackets, but it has been disapplied by the Finance Act 2023, freezing thresholds at their 2021/22 levels through fiscal year 2030/31 following extensions in the 2022 Autumn Statement and the 2025 Autumn Budget.

2.2 Korea as a motivating case

Korea does not operate a general automatic indexation rule for personal-income tax bracket thresholds. As Table 2 shows, statutory rates and thresholds have been amended on several occasions, but these changes did not amount to a comprehensive rescaling of the tax schedule in line with cumulative nominal income growth. In particular, the lower and middle thresholds remained fixed at 12, 46, and 88 million KRW from 2008 through 2022. In 2023, the two lowest thresholds were raised to 14 and 50 million KRW, while the 88 million KRW threshold remained unchanged. Over the same period, additional upper-income brackets were introduced and top statutory rates increased. These reforms affected a relatively small share of workers and represent discretionary changes in the structure of the tax schedule rather than systematic indexation of existing thresholds.

Between 2014 and 2022, nominal labor income grew because of both inflation and real wage growth, while the main tax-bracket thresholds remained unchanged. To summarize how workers moved through the statutory tax schedule, we use the National Tax Service's *Statistical Yearbook of National Tax* to construct a population-weighted average statutory

Table 2: Marginal Tax Rates and Tax Brackets

① **'96–'01**		② **'02–'04**		③ **'05–'07**		④ **'08**		⑤ **'09**		⑥ **'10–'11**	
Tax Base	Rate	Tax Base	Rate	Tax Base	Rate	Tax Base	Rate	Tax Base	Rate	Tax Base	Rate
≤ 10M	10%	≤ 10M	9%	≤ 10M	8%	≤ 12M	8%	≤ 12M	6%	≤ 12M	6%
≤ 40M	20%	≤ 40M	18%	≤ 40M	17%	≤ 46M	17%	≤ 46M	16%	≤ 46M	15%
≤ 80M	30%	≤ 80M	27%	≤ 80M	26%	≤ 88M	26%	≤ 88M	25%	≤ 88M	24%
> 80M	40%	> 80M	36%	> 80M	35%	> 88M	35%	> 88M	35%	> 88M	35%
⑦ **'12–'13**		⑧ **'14–'16**		⑨ **'17**		⑩ **'18–'20**		⑪ **'21–'22**		⑫ **'23–'25**	
Tax Base	Rate	Tax Base	Rate	Tax Base	Rate	Tax Base	Rate	Tax Base	Rate	Tax Base	Rate
≤ 12M	6%	≤ 12M	6%	≤ 12M	6%	≤ 12M	6%	≤ 12M	6%	≤ 14M	6%
≤ 46M	15%	≤ 46M	15%	≤ 46M	15%	≤ 46M	15%	≤ 46M	15%	≤ 50M	15%
≤ 88M	24%	≤ 88M	24%	≤ 88M	24%	≤ 88M	24%	≤ 88M	24%	≤ 88M	24%
≤ 300M	35%	≤ 150M	35%	≤ 150M	35%	≤ 150M	35%	≤ 150M	35%	≤ 150M	35%
> 300M	38%	> 150M	38%	≤ 500M	38%	≤ 300M	38%	≤ 300M	38%	≤ 300M	38%
				> 500M	40%	≤ 500M	40%	≤ 500M	40%	≤ 500M	40%
						> 500M	42%	≤ 1,000M	42%	≤ 1,000M	42%
								> 1,000M	45%	> 1,000M	45%

Source: Authors' compilation based on the *Income Tax Act* of the Republic of Korea. M: million KRW

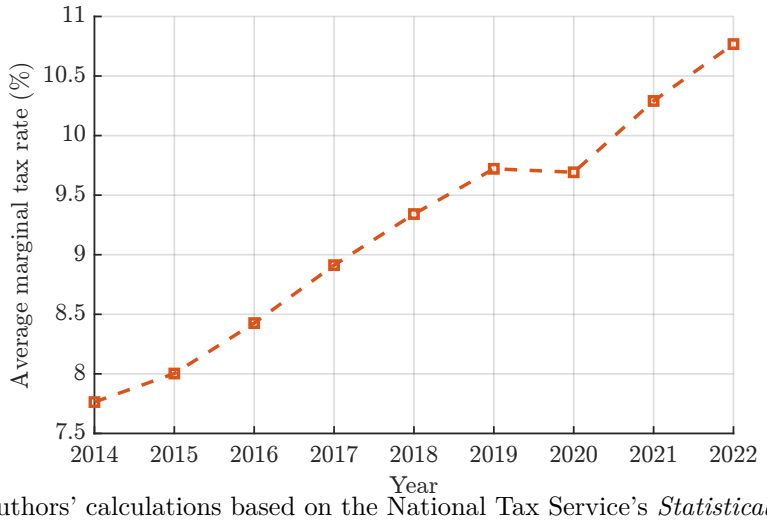
marginal labor-income tax rate.[1] For each year, we weight the statutory marginal rate in each taxable-income bracket by the number of workers whose tax base falls within that bracket. To limit the influence of newly introduced upper-income brackets and increases in top statutory rates, we assign a rate of 38 percent to all tax bases above 150 million KRW, corresponding to the top rate applied at the beginning of the sample.[2] As shown in Figure 1, the resulting measure increased by an average of approximately 0.375 percentage points per year over this period. This upward movement is consistent with fiscal drag.

We use these institutional patterns and the measured rise in the average statutory marginal tax rate to discipline the quantitative model. Korea serves as a motivating case, but the mechanism is more general: it applies to any progressive tax system in which nominal taxable income grows faster than tax-bracket thresholds and those thresholds are adjusted only intermittently.

[1]For 2014, the income ranges reported in the source do not align exactly with some statutory tax-bracket thresholds. We therefore use generalized Pareto interpolation (Blanchet et al., 2022) to allocate workers across the relevant upper-income ranges.

[2]Workers with tax bases above 150 million KRW accounted for approximately 0.32 percent of workers in 2014 and 0.74 percent in 2022.

Figure 1: Average Marginal Tax Rate over Time (2014–2022)



Source: Authors' calculations based on the National Tax Service's *Statistical Yearbook of National Tax*. Tax bases above 150 million KRW are assigned a marginal rate of 38 percent, as described in the text.

3 Model

3.1 Households

Household maximization problem The economy is populated by a unit mass of infinitely lived households. In period t, a household enters with real asset holdings A_t and idiosyncratic log labor productivity ϵ_t, and chooses consumption C_t, labor supply n_t, and next-period asset holdings A_{t+1}. Idiosyncratic log labor productivity follows the AR(1) process

$$\epsilon_{t+1} = \rho\epsilon_t + \sigma_\epsilon \eta_{t+1}, \qquad \eta_{t+1} \sim \mathcal{N}(0,1),$$

where $\rho \in [0,1)$ governs persistence and $\sigma_\epsilon > 0$ is the standard deviation of the innovation. The process is discretized into a finite-state Markov chain using the Rouwenhorst method (Rouwenhorst, 1995) for the numerical solution.

The household solves

$$\max_{\{C_t, n_t, A_{t+1}\}_{t=0}^{\infty}} E_0 \sum_{t=0}^{\infty} \beta^t u(C_t, n_t)$$

subject to

$$P_t C_t + P_t A_{t+1} = D_t(P_t W_t e^{\epsilon_t} n_t) + P_t \left[1 + (1 - \tau_k) r_t\right] A_t,$$

$$A_{t+1} \geq 0, \qquad C_t > 0, \qquad n_t \geq 0.$$

Here, P_t denotes the price level, W_t is the real wage per efficiency unit, r_t is the pre-tax net real return on assets, and $D_t(\cdot)$ is the period-t *disposable-income function*, described in detail below. Capital income is taxed separately at the proportional rate τ_k[3].

Preferences are given by

$$u(C_t, n_t) = \log C_t - \chi \frac{n_t^{1+1/\nu}}{1 + 1/\nu},$$

where $\chi > 0$ governs the disutility of labor and $\nu > 0$ is the Frisch elasticity of labor supply under this specification. These preferences are consistent with balanced growth (King, Plosser, and Rebelo, 1988).

Let $\gamma > 1$ denote the gross annual growth rate of labor-augmenting technology. We define detrended variables as

$$c_t \equiv \frac{C_t}{\gamma^t}, \qquad a_t \equiv \frac{A_t}{\gamma^t}, \qquad w_t \equiv \frac{W_t}{\gamma^t}.$$

Dividing the household budget constraint by $P_t \gamma^t$, we obtain

$$c_t + \gamma a_{t+1} = \frac{D_t(P_t \gamma^t w_t e^{\epsilon_t} n_t)}{P_t \gamma^t} + \left[1 + (1 - \tau_k) r_t\right] a_t,$$

$$a_{t+1} \geq 0, \qquad c_t > 0, \qquad n_t \geq 0.$$

Because $\log C_t = \log c_t + t \log \gamma$, detrending removes only a deterministic term from lifetime utility that is independent of the household's choices and therefore does not affect the optimal policy functions.

[3]Appendix A considers the alternative in which the progressive schedule is levied on total income, so that labor and capital income are aggregated into a single tax base. The results are quantitatively similar.

Tax system parameterization We approximate the progressive labor-income tax schedule using a modified version of the disposable-income function proposed by Heathcote, Storesletten, and Violante (2017), henceforth HSV. The HSV specification provides a smooth, two-parameter representation of the overall level and progressivity of a nonlinear tax schedule and is differentiable at every income level.

Under the original HSV specification, nominal disposable labor income is

$$D(Y) = \lambda Y^{1-\tau},$$

where $Y > 0$ denotes nominal taxable labor income. The corresponding tax liability is

$$Tax(Y) = Y - D(Y) = Y - \lambda Y^{1-\tau}.$$

The parameter $\lambda > 0$ primarily governs the overall level of taxation, while $\tau \in [0, 1)$ governs progressivity. When $\tau = 0$, disposable income is proportional to taxable income, and both the average and marginal tax rates are equal to $1 - \lambda$. When $\tau > 0$, both rates increase with income.

To incorporate the indexation regimes introduced in Section 2.1, let $M_t > 0$ denote the nominal position of the tax schedule. Although the HSV specification does not contain literal tax brackets, M_t plays the role of a common scale factor applied to tax-bracket thresholds. We specify nominal disposable labor income as

$$D_t(Y_t) = M_t \lambda \left(\frac{Y_t}{M_t} \right)^{1-\tau}. \tag{1}$$

Equation (1) first expresses nominal taxable income relative to the position of the tax schedule, applies the HSV disposable-income function to that relative income, and then converts disposable income back into nominal units by multiplying by M_t. Consequently, average and marginal tax rates depend on the ratio Y_t/M_t. If income and the tax schedule

grow at the same rate, effective tax rates remain unchanged; if income grows faster than the tax schedule, they rise.

It is instructive to consider two special cases. First, suppose that the government never adjusts the nominal tax-bracket thresholds, so that the nominal position of the tax schedule remains fixed. We normalize this case as $M_t = 1$ for all t. Because aggregate nominal wages grow while idiosyncratic log productivity follows a stationary process, nominal labor income grows without bound for workers who continue to supply positive labor. In a literal bracket system with fixed nominal thresholds, all such workers would therefore eventually enter the highest statutory tax bracket. In the smooth HSV representation, the corresponding limiting result is that both average and marginal tax rates converge to one when $\tau > 0$.

The second special case is full nominal-income indexation. In this regime, the government adjusts the nominal tax-bracket thresholds each period in line with trend nominal income growth. In the model, this corresponds to setting

$$M_t = P_t \gamma^t.$$

Substituting this expression into Equation (1) gives

$$D_t(Y_t) = P_t \gamma^t \lambda \left(\frac{Y_t}{P_t \gamma^t} \right)^{1-\tau} = P_t \gamma^t \lambda y_t^{1-\tau},$$

where

$$y_t \equiv \frac{Y_t}{P_t \gamma^t}$$

denotes detrended taxable labor income. Effective tax rates therefore depend on y_t, but not on the common nominal growth trend $P_t \gamma^t$. A household whose position in the detrended income distribution remains unchanged consequently faces the same average and marginal tax rates over time. Full nominal-income indexation thus removes both inflation-induced bracket creep and the fiscal drag associated with trend real income growth.

Full nominal-income indexation provides a useful benchmark, but many tax systems adjust nominal tax-bracket thresholds more slowly than trend nominal income. To summarize the relative position of nominal income and the tax schedule, define the *indexation ratio*

$$s_t \equiv \frac{P_t \gamma^t}{M_t}.$$

Under full nominal-income indexation, $s_t = 1$. More generally, the ratio remains constant when the nominal position of the tax schedule grows at the same rate as trend nominal income. When trend nominal income grows faster than the tax schedule, s_t rises, indicating a widening indexation gap.

Dividing nominal disposable labor income by trend nominal income, $P_t \gamma^t$, define detrended disposable labor income as

$$d_t(y_t) \equiv \frac{D_t(Y_t)}{P_t \gamma^t} = \lambda s_t^{-\tau} y_t^{1-\tau}, \tag{2}$$

where

$$y_t \equiv \frac{Y_t}{P_t \gamma^t}$$

denotes detrended taxable labor income. The corresponding effective average and marginal tax rates are

$$ATR_t(y_t) \equiv 1 - \frac{d_t(y_t)}{y_t} = 1 - \lambda s_t^{-\tau} y_t^{-\tau}, \tag{3}$$

$$MTR_t(y_t) \equiv 1 - d_t'(y_t) = 1 - (1-\tau)\lambda s_t^{-\tau} y_t^{-\tau}. \tag{4}$$

Equations (2)–(4) make the mechanism transparent. Under imperfect indexation (e.g., inflation indexation or no indexation), trend nominal income grows faster than the nominal position of the tax schedule. As a result, the indexation ratio s_t rises and the indexation gap widens. For given y_t, disposable income falls, and both the effective average and marginal tax rates increase. Under full indexation, by contrast, s_t remains constant, so common inflation and trend real income growth do not change effective tax rates for a household at a fixed position

in the detrended income distribution.

In our quantitative exercises, under imperfect indexation the government resets the nominal position of the tax schedule every T years. Indefinite non-adjustment would be implausible: as nominal incomes continue to grow, workers with positive labor income would eventually be pushed into the highest statutory tax bracket, giving the government a reason to revise the schedule at some point. At the beginning of each new tax cycle, M_t is adjusted so that the indexation ratio—and hence the schedule-induced component of effective tax rates—returns to its level at the beginning of the preceding cycle. Between reset dates, M_t grows at a prespecified rate determined by the indexation regime. Under inflation indexation, it grows with the price level, whereas under no automatic indexation it remains fixed. Under full indexation, M_t grows continuously with trend nominal income, so the indexation ratio remains constant and the reset is immaterial.

Formally, write $t = kT + j$, where $k \geq 0$ indexes ***tax cycles*** and $j \in \{1, \ldots, T\}$ denotes the period within cycle k. Let Γ denote the gross rate at which the nominal position of the tax schedule evolves between reset dates. This rate depends on the indexation regime:

$$\Gamma = \begin{cases} (1+\pi)\gamma, & \text{under full indexation,} \\ 1+\pi, & \text{under inflation indexation,} \\ 1, & \text{under no automatic indexation,} \end{cases}$$

where $1 + \pi$ is the gross inflation rate. Within a tax cycle, the nominal position of the tax schedule is therefore given by

$$M_{j+kT} = \Gamma^{j-1} M_{1+kT}, \qquad 1 \leq j \leq T. \tag{5}$$

At the beginning of the next cycle, the government resets the schedule according to

$$M_{1+(k+1)T} = M_{1+kT}\Big[(1+\pi)\gamma\Big]^T, \qquad k \geq 0. \tag{6}$$

Thus, the nominal position of the tax schedule at the beginning of each cycle increases by the cumulative growth of trend nominal income over the preceding T periods. Under imperfect indexation, this adjustment closes the indexation gap accumulated within the cycle. Under full indexation, the same adjustment occurs continuously, so no discrete reset is required.

Equations (5) and (6) imply that the indexation ratio follows the same within-cycle path in every tax cycle:

$$s_{j+kT} = s_j, \qquad k \geq 0, \quad 1 \leq j \leq T.$$

Thus, s_t depends only on the period j within the tax cycle. Under imperfect indexation, it rises between reset dates as the indexation gap widens, and falls when the government resets the nominal position of the tax schedule. The indexation ratio therefore follows a recurring sawtooth pattern. Under full indexation, by contrast, it remains constant throughout the cycle. For convenience, we assume that T is odd and normalize the indexation ratio to one at the midpoint of each cycle, $j = (T+1)/2$.[4] The within-cycle indexation ratio can then be written as

$$s_j = q^{j-(T+1)/2}, \qquad q \equiv \frac{(1+\pi)\gamma}{\Gamma}.$$

The parameter q measures the gross growth of trend nominal income relative to the nominal position of the tax schedule between reset dates. Hence, $q = 1$ under full indexation, $q = \gamma$ under inflation indexation, and $q = (1+\pi)\gamma$ under no automatic indexation. The midpoint normalization makes the tax schedule at the center of the cycle comparable to the fully indexed schedule and isolates within-cycle variation from a permanent difference in the overall level of taxation.

Because $s_{j+kT} = s_j$, the detrended disposable-income function also follows the same within-cycle path in every tax cycle:

$$d_{j+kT}(y) = d_j(y), \qquad k \geq 0, \quad 1 \leq j \leq T.$$

[4]The assumption that T is odd is not essential.

Consequently, for any given detrended taxable labor income y, detrended disposable income and the effective average and marginal tax rates depend only on the within-cycle position j, not on the cycle index k. Under imperfect indexation, effective tax rates rise between reset dates and fall discretely when the government resets the nominal position of the tax schedule, thereby exhibiting a recurring sawtooth-like pattern. Under full indexation, by contrast, they remain constant over the cycle.

Bellman-equation formulation. Given the periodic tax cycle described above, the household problem can be written recursively by including the within-cycle position j as a state variable:

$$V_j(a,\epsilon) = \max_{a',c,n} \{u(c,n) + \beta E[V_{j'}(a',\epsilon') \mid \epsilon]\}$$

subject to

$$c + \gamma a' = [1 + (1-\tau_k)r_j]\, a + d_j(w_j e^{\epsilon} n)\,,$$

$$a' \geq 0, \qquad c > 0, \qquad n \geq 0,$$

where

$$j' = \begin{cases} j+1, & j < T, \\ 1, & j = T. \end{cases}$$

Thus, after the final period of one tax cycle, the within-cycle state returns to $j = 1$, while idiosyncratic labor productivity evolves according to the AR(1) process specified above.

3.2 Firms

A representative competitive firm produces goods using capital and effective labor. After removing the common labor-augmenting technology trend γ^t, the firm's problem in period j of the tax cycle is

$$\max_{k_j^d, n_j^d} \left\{ (k_j^d)^{\theta} (n_j^d)^{1-\theta} - (r_j + \delta) k_j^d - w_j n_j^d \right\},$$

where k_j^d and n_j^d denote the firm's demands for detrended capital and effective labor, respectively, and δ is the depreciation rate. The first-order conditions are

$$r_j = \theta(k_j^d)^{\theta-1}(n_j^d)^{1-\theta} - \delta, \tag{7}$$

$$w_j = (1-\theta)(k_j^d)^{\theta}(n_j^d)^{-\theta}. \tag{8}$$

3.3 Government and Fiscal Closure

Government purchases. The government purchases an exogenously specified quantity of the final good. Aggregate government purchases in period t are given by

$$G_t = \gamma^t g,$$

where g denotes government purchases in detrended units. Thus, government purchases grow at the same trend rate as the economy and remain constant in detrended terms.

Tax revenue. For a household with detrended taxable labor income y, detrended disposable labor income in period j of the tax cycle is $d_j(y)$. The household's detrended labor-income tax payment is therefore

$$\mathcal{T}_j(y) \equiv y - d_j(y).$$

Aggregate detrended tax revenue in period j is

$$R_j = \int \left[\mathcal{T}_j(w_j e^{\epsilon} n_j(a,\epsilon)) + \tau_k r_j a\right] d\Psi_j(a,\epsilon),$$

where $\Psi_j(a,\epsilon)$ denotes the distribution of households over assets and idiosyncratic labor productivity in period j. The first term inside the integral is labor-income tax revenue, while the second is capital-income tax revenue.

Government assets and debt. The government is allowed to borrow and save within a tax cycle. Let b_j denote the government's detrended net financial asset position at the beginning of period j. A positive value of b_j represents net government assets, whereas a negative value represents net government debt. The government's period-by-period budget constraint is

$$\gamma b_{j+1} = R_j - g + (1 + r_j)b_j, \qquad j = 1, \ldots, T,$$

where b_{T+1} denotes the government's net financial position at the beginning of the next tax cycle.

The term $R_j - g$ is the primary fiscal balance in period j. When $R_j < g$, the government finances the shortfall by drawing down its assets or increasing its debt; when $R_j > g$, it accumulates assets or reduces its debt. The term $(1 + r_j)b_j$ is the gross value of the financial position carried into period j, including the return earned on government assets or the interest paid on government debt. The factor γ on the left-hand side appears because b_{j+1} is expressed in next period's detrended units, whereas the terms on the right-hand side are expressed in current-period detrended units.

Fiscal comparability across indexation regimes. Across indexation regimes, we hold fixed the government-purchase path, the progressivity parameter τ, and the capital-income tax rate τ_k.

At the level of the tax cycle, we impose two additional conditions. First, every indexation regime must raise the same total amount of tax revenue over the cycle. Because detrended government purchases equal g in each period, we require

$$\frac{1}{T}\sum_{j=1}^{T} R_j = g. \tag{9}$$

Equivalently, cycle-total tax revenue equals Tg, the common total amount of government purchases over the cycle. This condition holds total tax collections fixed across regimes while

allowing the within-cycle revenue profile $\{R_j\}_{j=1}^T$ to differ. Second, within each regime, the government's net financial position must be periodic:

$$b_{T+1} = b_1.$$

This condition prevents government assets or debt from accumulating across successive tax cycles.

Given the equilibrium paths of tax revenue and interest rates, the government budget constraint and the periodicity condition determine the beginning-of-cycle position b_1 and the entire sequence $\{b_j\}_{j=1}^T$. Since the within-cycle paths of tax revenue and interest rates generally differ across indexation regimes, the sequences need not be the same. In a regime other than full indexation, tax revenue rises within the cycle: it falls short of g in the early, low-tax phase and exceeds g in the later, high-tax phase. The government therefore runs deficits at the beginning of each cycle and surpluses toward the end, generating a U-shaped path of government's net asset position. Starting from a positive level, savings are drawn down during the low-tax phase, turn negative, and recover once revenue rises above g, returning to their initial level at the start of the next cycle.[5]

Adjustment of the tax level. The progressivity parameter τ, the expenditure level g, and the indexation rule are held fixed within each experiment. For each indexation regime and reset interval T, we choose the tax-level parameter λ so that (9) is satisfied.

[5]Given the equilibrium paths $\{R_j, r_j\}_{j=1}^T$, the government budget constraint and the periodicity condition $b_{T+1} = b_1$ uniquely determine b_1 and the sequence $\{b_j\}_{j=1}^T$. Moreover, summing the government budget constraints over the cycle and imposing $\sum_{j=1}^T R_j = Tg$ and $b_{T+1} = b_1$ yields

$$\sum_{j=1}^{T} (\gamma - 1 - r_j) b_j = 0.$$

Thus, the fiscal closure imposes an interest- and growth-adjusted restriction on the government asset path. Since $r_j > \gamma - 1$ in equilibrium, the government asset positions must sum to zero when weighted by $1 + r_j - \gamma$. Intuitively, if average savings were systematically positive, the resulting interest income would allow the government to finance g with less than the required average revenue, violating either (9) or the stationarity of $\{b_j\}$. Uniqueness follows because $(1 + r_j)/\gamma > 1$, so the periodic boundary condition admits a single solution for b_1.

Recall that a lower value of λ implies lower disposable income and therefore a higher overall tax burden. If fiscal drag reduces labor supply, output, or the tax base, the government may need to select a lower λ in order to finance the same expenditure path while returning to the same end-of-cycle asset position. The resulting change in λ is therefore part of the welfare cost of fiscal drag: a more distortionary tax regime requires a higher average tax burden to raise the same amount of resources.

In summary, the fiscal closure makes the alternative indexation regimes comparable in four respects. First, the government follows the same government-purchase path in every regime. Second, every regime raises the same total amount of tax revenue over the tax cycle. Third, the progressivity parameter τ and the capital-income tax rate τ_k are held fixed across regimes. Finally, within each regime, the government's net financial position returns to its own beginning-of-cycle level, preventing government assets or debt from drifting across successive cycles. Consequently, no regime can appear more attractive merely because it provides fewer public goods, collects less total tax revenue, applies different tax parameters, or permanently shifts its fiscal burden to future cycles. Welfare differences instead reflect the within-cycle timing and variation of effective tax rates and the resulting equilibrium responses.

3.4 Periodic stationary equilibrium

In a conventional stationary equilibrium, detrended prices, household policy functions, and the distribution of households are invariant over time. Under imperfect indexation, however, the position within the tax cycle becomes an aggregate state. To illustrate, consider a reset interval of $T = 3$. Immediately after the tax schedule is reset, the economy is in phase $j = 1$. As income subsequently grows faster than the nominal tax parameters, effective tax rates rise in phases $j = 2$ and $j = 3$. The tax schedule is then reset, and the economy returns to phase $j = 1$. Prices, household decisions, and the distribution of households may therefore differ across the three phases $j = 1, 2, 3$, but the entire sequence repeats every $T = 3$ periods. More generally, with a reset interval T, the economy follows a periodic stationary equilibrium:

detrended allocations need not be constant from one period to the next, but the sequence of prices, policies, distributions, and government financial positions repeats after T periods. Under full nominal-income indexation, the phases are identical and the periodic equilibrium collapses to an ordinary stationary equilibrium.

Definition 1 (Periodic stationary equilibrium)**.** *For a given indexation rule* Γ*, reset interval* T*, tax-progressivity parameter* τ*, inflation rate* π*, and trend-growth factor* γ*, a* ***periodic stationary equilibrium*** *consists of household policy functions* $\{a'_j(a,\epsilon), c_j(a,\epsilon), n_j(a,\epsilon)\}_{j=1}^T$*, factor prices* $\{w_j, r_j\}_{j=1}^T$*, firm policy functions* $\{k_j^d, n_j^d\}_{j=1}^T$*, government asset positions* $\{b_j\}_{j=1}^T$*, distributions* $\{\Psi_j(a,\epsilon)\}_{j=1}^T$*, and a tax-level parameter* λ *such that the following conditions hold and all objects repeat after* T *periods.*

1. All optimal policy functions are the solutions of the problems in Sections 3.1, 3.2.

2. Factor markets are competitive: Equations (7) and (8).

3. Factor markets clear.

$$\int a d\Psi_j(a,\epsilon) + b_j = k_j^d \quad \text{for} \quad j = 1, \cdots, T$$

$$\int e^{\epsilon} n_j(a,\epsilon) d\Psi_j(a,\epsilon) = n_j^d \quad \text{for} \quad j = 1, \cdots, T$$

4. Product market clears.

$$\int (c_j(a,\epsilon) + \gamma a'_j(a,\epsilon) - (1-\delta)a) d\Psi_j(a,\epsilon) + \gamma b_{j+1} - (1-\delta) b_j + g = k_j^{d^\theta} n_j^{d^{1-\theta}} \quad \text{for} \quad j = 1, \cdots, T$$

5. Government budget constraint holds.

$$\gamma b_{j+1} = R_j - g + (1 + r_j) b_j \quad \text{for} \quad j = 1, \cdots, T-1$$

$$\gamma b_1 = R_T - g + (1 + r_T) b_T$$

6. Distributional consistency: The next phase's distribution is generated by current policy choices and the productivity transition. Let $X = A \times E$ denote the individual state space, where $A = [0, \infty)$ is the asset space and E is the finite support of idiosyncratic productivity, and let $\mathcal{B}(X)$ denote the associated Borel σ-algebra. Then distributional consistency requires:

$$\int_B d\Psi_{j+1}(a, \epsilon) = \int P_j((a, \epsilon), B) d\Psi_j(a, \epsilon) \quad \text{for} \quad \forall B \in \mathcal{B}(X) \quad \text{for} \quad j = 1, \cdots, T-1$$

$$\int_B d\Psi_1(a, \epsilon) = \int P_T((a, \epsilon), B) d\Psi_T(a, \epsilon) \quad \text{for} \quad \forall B \in \mathcal{B}(X),$$

where $P_j((a, \epsilon), B)$ is the transition probability induced by optimal policy functions and the Markov chain for idiosyncratic productivity.

4 Quantitative Results

4.1 Data and calibration

Quantitative differences across indexation regimes depend on how rapidly the indexation gap accumulates and how strongly households respond to the resulting changes in effective tax rates. The inflation rate π and the gross trend-growth factor γ, together with the indexation rule, determine how rapidly trend nominal income grows relative to the nominal position of the tax schedule. The progressivity parameter τ governs how strongly a given indexation gap changes effective average and marginal tax rates, while the Frisch elasticity ν governs the labor-supply response to those changes. Finally, the reset interval T determines how long the indexation gap is allowed to accumulate before the tax schedule is adjusted.

The baseline calibration, summarized in Table 3, targets selected features of the Korean economy over 2014–2022.[6] Average CPI inflation over this period is 1.69 percent, and the

[6]We begin the calibration window in 2014 because Korea implemented a major reform of its income-tax deduction and credit system that year, which affects the comparability of the tax data. The choice of this window does not imply that fiscal drag was absent outside the 2014–2022 period.

gross trend-growth factor is set to $\gamma = 1.0184$, corresponding to average annual real wage growth of 1.84 percent. The capital share and depreciation rate are set to conventional annual values. We set the Frisch elasticity to one. The discount factor is chosen to deliver a net real interest rate of 6 percent in the benchmark economy, and the labor-disutility parameter is chosen to match average hours of 0.2. Finally, the detrended government-purchase level g is set equal to stationary-equilibrium tax revenue under the full-indexation regime, so that the government budget is balanced period by period and the government holds no net assets or debt in that benchmark.

The progressivity parameter τ and the tax-level parameter λ play distinct roles. The parameter τ governs how strongly effective average and marginal tax rates rise as taxable income increases relative to the nominal position of the tax schedule. We choose τ to match the average annual increase of approximately 0.375 percentage points in the population-weighted average statutory marginal labor-income tax rate between 2014 and 2022, constructed in Section 2.2. The model approximates the observed time-series drift well, as shown in Figure 2. In addition, as an external validation, Figure 3 shows that the calibrated HSV schedule also approximates the cross-sectional variation in the marginal tax rates fairly well.

The parameter λ, by contrast, governs the overall level of effective tax rates. In the benchmark calibration, we choose λ to match the population-weighted average statutory marginal labor-income tax rate in 2018. For each alternative indexation regime and reset interval T, we then adjust λ so that the cycle-total revenue condition in Equation (9) is satisfied. Differences in λ across regimes therefore reflect the adjustment in the overall tax level required to hold total tax collections over the cycle fixed.

The parameters ρ and σ_ϵ, which govern the persistence and dispersion of idiosyncratic log labor productivity, are chosen jointly to match the Gini coefficients of pre-tax income and wealth. The corresponding empirical moments are constructed using the *Survey of Household Finances and Living Conditions*. Table 4 compares the resulting model moments with their empirical counterparts. The after-tax income Gini, which is not directly targeted, provides

Figure 2: AMTR over Time (2014–2022)

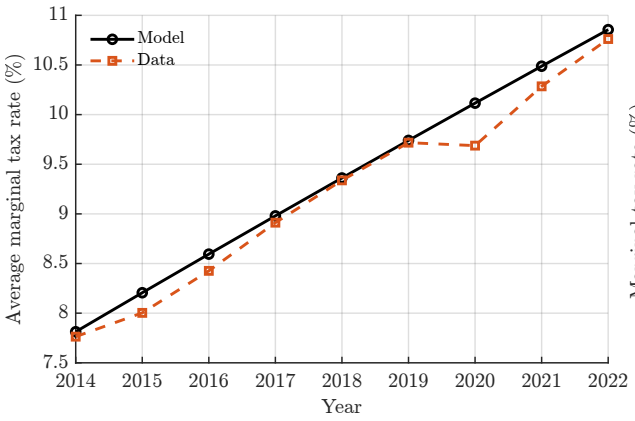


Figure 3: Marginal tax rate by labor income: Model (Full Indexation) vs Data (2018)



Note: In Figure 2, the model series is the average marginal tax rate over the middle nine periods of the tax cycle under no automatic indexation. In Figure 3, the model schedule is computed under full indexation, which is comparable to the midpoint of the cycle; small bumps reflect the discretization of idiosyncratic productivity. The negative model rates at the bottom reflect the implicit transfers embedded in the HSV specification. In both figures, the data assign a marginal rate of 38 percent to tax bases above 150 million KRW.

an additional check on the model's distributional implications.

The calibration window should be distinguished from the tax-schedule reset interval T. Observations from 2014–2022 are used to discipline trend inflation, real wage growth, and the increase in the population-weighted average statutory marginal labor-income tax rate. The parameter T, by contrast, governs how long incomplete indexation persists before the tax schedule is reset in the model. It therefore describes the persistence of the indexation gap rather than the length of the calibration window.

As documented in Table 2, Korea made occasional changes to individual statutory rates and tax-bracket thresholds over the past three decades. These amendments, however, did not constitute a comprehensive rescaling of the tax schedule in line with cumulative nominal income growth. Several important thresholds remained fixed for extended periods, while many of the observed reforms involved changes in top statutory rates or the introduction of additional upper-income brackets. The institutional evidence therefore suggests that incomplete indexation persisted over a substantially longer horizon than the 2014–2022 calibration window alone.

Motivated by this longer institutional history, the baseline mechanism exercise sets $T = 31$. This choice should not be interpreted as implying that the Korean government follows a regular 31-year schedule for comprehensively resetting the tax system. The reset at the end of the model cycle is a stationarity device that closes the periodic equilibrium. The deterministic cycle instead provides a tractable stationary representation of a prolonged period of partial and infrequent tax-schedule adjustment.

Table 3: Baseline calibration

External Parameters		
Parameter	**Value**	**Target**
π (Inflation rate)	0.0169	Average CPI Inflation Rate(2014∼2022)
γ (Growth rate)	1.0184	Average Real Wage Growth(2014∼2022)
θ (Cobb-Douglas parameter)	0.36	Conventional
ν (Frisch elasticity)	1	Han, Woo, and Hong (2018)
δ (Depreciation rate)	0.066	Conventional
τ_k (Capital tax rate)	0.25	OECD Effective Corporate Tax Rate (2024)
Internal Parameters		
Parameter	**Value**	**Target**
λ (HSV tax level)	0.8552	Average marginal tax rate at 2018
χ (Labor disutility)	18.075	Work Hour=0.2
β (Discount factor)	0.9583	Real Interest Rate=6% in full indexation
τ (Tax Progressivity)	0.125	Annual Change in Average Marginal Tax Rate=0.375%p
ρ (Persistence of Labor Productivity)	0.9	Gini Coefficients
σ_ϵ (Standard Deviation of Labor Productivity)	0.283	Gini Coefficients

Table 4: Inequality moments

	Model	**Data**
Before Tax Income Gini	0.4081	0.4011
After Tax Income Gini	0.3673	0.3324
Wealth Gini	0.6316	0.5999

Note: Model moments are computed in the stationary equilibrium under full indexation. Data moments are authors' calculations based on the *Survey of Household Finances and Living Conditions*, 2017–2024.

4.2 Within-cycle dynamics

To illustrate the mechanism under a prolonged period of incomplete indexation, Figure 4 reports equilibrium dynamics within a $T = 31$ tax cycle. As discussed above, this horizon is motivated by the approximately three-decade institutional history summarized in Table 2, during which the Korean tax schedule was amended but not comprehensively rescaled in line with cumulative nominal income growth. The exercise should therefore be interpreted as a stylized representation of persistent under-indexation, rather than as a literal description of a regularly recurring 31-year legislative cycle.

The comparison holds the government-purchase path and cycle-total tax revenue fixed across indexation regimes. The tax-level parameter λ is therefore adjusted separately in each regime to satisfy the common revenue target. Within each regime, the government's net financial position also satisfies the periodicity condition $b_{T+1} = b_1$.

Effective tax rates. The top two panels of Figure 4 show the evolution of the population-average effective average tax rate and the population-average effective marginal tax rate. Under imperfect indexation, trend nominal income grows faster than the nominal position of the tax schedule. The indexation ratio s_j therefore rises between reset dates, causing both effective tax rates to increase over the cycle.

The increase is larger under no automatic indexation than under inflation indexation. Under no automatic indexation, both inflation and trend real income growth widen the indexation gap. Under inflation indexation, the nominal tax schedule keeps pace with inflation, but not with trend real income growth, so the indexation gap still widens, although more slowly. Under full indexation, the nominal position of the tax schedule grows in line with trend nominal income. The indexation ratio remains constant, and effective average and marginal tax rates exhibit no within-cycle movement.

Labor supply and tax revenue. The middle-left panel of Figure 4 shows the response of aggregate effective labor. As the effective marginal tax rate rises, the after-tax return to an additional unit of labor falls. Households consequently reduce labor supply over the cycle. The decline is more pronounced under no automatic indexation because the increase in the effective marginal tax rate is larger. Under full indexation, both the tax schedule and labor supply remain constant within the cycle.

The labor-supply response also changes the tax base. Rising effective tax rates increase the amount of tax collected from a given level of taxable income, while the associated decline in labor supply reduces taxable labor income. In the equilibrium, the direct rate effect dominates, so tax revenue rises over the cycle, as shown in the middle-right panel. Its rate of increase nevertheless becomes smaller as the contraction of the tax base partly offsets the effect of higher tax rates.

This curvature in the revenue path should be interpreted as an equilibrium outcome of the interaction between tax rates and the endogenous tax base. The relevant economic mechanism is that higher marginal tax wedges reduce labor supply and taxable income, thereby limiting the revenue collected during the later, high-tax phase.

Saving and capital accumulation. The bottom-left panel of Figure 4 shows that aggregate capital follows a hump-shaped path under imperfect indexation. Households understand the deterministic evolution of future tax rates and adjust saving in response to the resulting changes in disposable labor income. Following the reset, effective tax rates are relatively low and disposable labor income is relatively high. Households accumulate assets in part to smooth consumption against the higher tax burdens expected later in the cycle.

As the economy moves into the high-tax phase, households draw down part of the assets accumulated earlier. Moreover, as the next reset approaches, the need to continue building financial buffers against further tax increases diminishes. Aggregate capital therefore rises during the early part of the cycle and declines later. The movement is larger under no

automatic indexation because the corresponding variation in disposable income and tax rates is greater.

Aggregate output. The bottom-right panel of Figure 4 reports the resulting path of aggregate output. Early in the cycle, relatively low effective tax rates support labor supply, while capital is increasing. Output can therefore initially exceed its full-indexation level. As effective tax rates continue to rise, however, effective labor declines and capital eventually begins to fall. Output then weakens and falls below the full-indexation benchmark during the later part of the cycle.

The later output losses outweigh the earlier gains. Cycle-average output is consequently lower under imperfect indexation than under full indexation, and the reduction is larger under no automatic indexation than under inflation indexation. Under full indexation, effective tax rates, labor supply, capital, tax revenue, and output remain constant within the cycle.

Welfare implications. The dynamics in Figure 4 describe how the tax cycle is transmitted through household labor supply, tax revenue, saving, and aggregate output. They point to three conceptually distinct channels through which the tax cycle lowers welfare.[7]

First, imperfect indexation generates a tax-variation channel, reflecting the classic welfare cost of imperfect tax smoothing. Consider a constant path of effective marginal tax rates and a fluctuating path with the same cycle-average tax level. Tax-rate variation induces households to work more in lower-tax phases and less in higher-tax phases. Because the disutility of labor is convex, this tax-induced variation in labor supply creates a welfare loss in the absence of corresponding fiscal or aggregate shocks.

Second, imperfect indexation generates a revenue-level channel. Effective tax rates and tax revenue rise over the cycle, but higher effective marginal tax rates reduce labor supply and taxable income. Tax revenue therefore increases at a diminishing rate, producing a concave

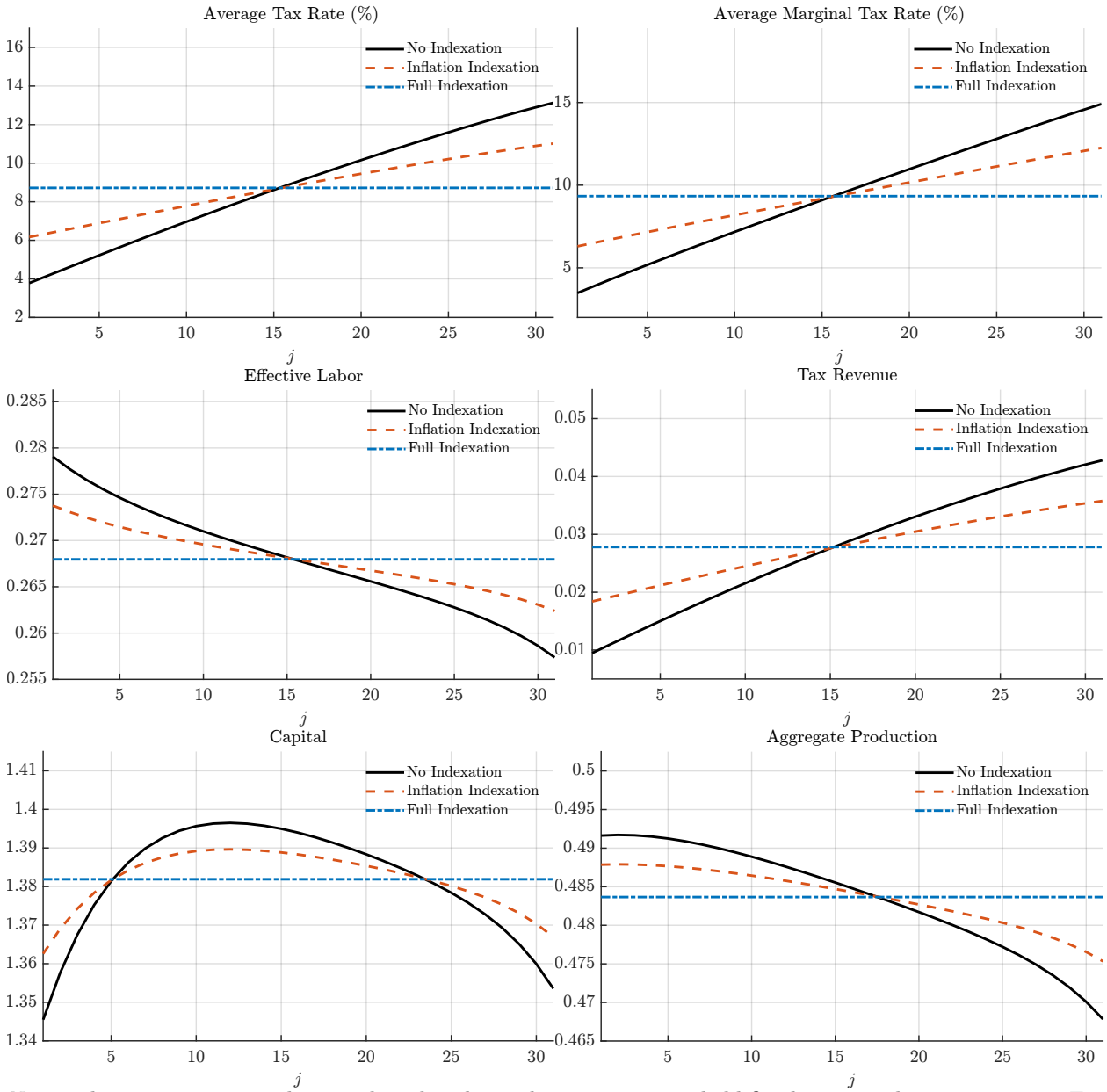
[7]The quantitative welfare measure incorporates all equilibrium effects jointly. Our analysis does not provide a numerical decomposition of the total welfare loss into these three channels.

equilibrium revenue path with respect to the within-cycle position j. At a given value of λ, this tax-base erosion reduces cycle-total revenue. To satisfy the common revenue target, the government must choose a lower λ, thereby raising the overall level of effective average and marginal tax rates.

Although closely related, the two channels operate through different margins: the tax-variation channel works through fluctuations in tax wedges at a given overall tax level, whereas the revenue-level channel works through the higher overall tax burden required to offset the endogenous erosion of the tax base.

Third, incomplete markets generate a limited self-insurance channel. Households with sufficient liquid asset buffers can use saving and dissaving to smooth consumption across the tax cycle. Households with little or no liquid wealth have less capacity to self-insure, so fluctuations in disposable income pass more directly into consumption. The same tax cycle can therefore impose larger welfare costs on households with limited self-insurance capacity. Section 4.6 examines this channel and its heterogeneous welfare consequences in greater detail.

Figure 4: Macroeconomic Variables within a Tax Cycle



Note: The government-purchase path and cycle-total tax revenue are held fixed across indexation regimes. For each regime, the tax-level parameter λ is chosen so that $\sum_{j=1}^{T} R_j = Tg$, and the government's net financial position satisfies the within-regime periodicity condition $b_{T+1} = b_1$.

4.3 The reset interval

The preceding analysis fixes the reset interval at $T = 31$. We now vary T to examine how the persistence of incomplete indexation affects macroeconomic outcomes and welfare. The reset interval should be interpreted as the length of time over which the indexation gap is allowed to accumulate before the nominal position of the tax schedule is comprehensively adjusted. It is not intended to represent the frequency of every minor statutory amendment.

For a given imperfect-indexation rule, increasing T does not change the rate at which the indexation gap widens from one period to the next. It allows that gap to accumulate for a longer period before the reset. The within-cycle range of the indexation ratio s_j, and hence the variation in effective average and marginal tax rates, therefore becomes larger as T increases. When $T = 1$, the tax schedule is reset every model period, so no indexation gap accumulates and the imperfect-indexation regimes coincide with full indexation. Under full indexation, the indexation ratio is constant regardless of T, making the reset interval irrelevant.

Figure 5 reports the tax-level parameter λ, cycle-average output, cycle-average consumption, and welfare for alternative values of T. Output and consumption are reported as percentage changes relative to full indexation, and welfare is measured by the consumption-equivalent variation.[8] For every value of T, λ is chosen separately under inflation indexation and no automatic indexation so that average tax revenue equals g. Within each equilibrium,

[8]For regime x, define average welfare over the phases of the tax cycle as

$$\overline{V}^{\,x} = \frac{1}{T}\sum_{j=1}^{T}\int V_j^x(a,\epsilon)\, d\Psi_j^x(a,\epsilon).$$

Relative to full indexation F, the consumption-equivalent variation is

$$\text{CEV}^x = \exp\left[(1-\beta)\left(\overline{V}^{\,x} - \overline{V}^{\,F}\right)\right] - 1.$$

Because utility is logarithmic in consumption, this measure gives the uniform proportional adjustment to consumption under full indexation that makes households indifferent between full indexation and regime x. A negative value therefore represents a welfare loss relative to full indexation. Averaging across phases gives equal weight to each position in the deterministic tax cycle.

the government's net financial position also satisfies $b_{T+1} = b_1$.

The upper-left panel shows that λ declines as the reset interval widens. A longer interval generates a larger increase in effective tax rates between resets and a stronger decline in labor supply and taxable income. Tax revenue continues to increase over the cycle, but it does so at a diminishing rate, producing a more pronounced concave revenue path with respect to the within-cycle position j. At a given value of λ, this tax-base feedback limits the amount of revenue collected over the cycle. A lower λ, and hence a higher overall level of effective tax rates, is therefore required to satisfy the common average-revenue condition.

A wider reset interval also strengthens the direct welfare cost of imperfect tax smoothing. As the within-cycle dispersion of effective marginal tax rates increases, households work increasingly more during the earlier, lower-tax phases and less during the later, higher-tax phases. Thus, a larger T increases both the variation in labor-supply incentives and, through the tax-base feedback described above, the overall level of effective tax rates.

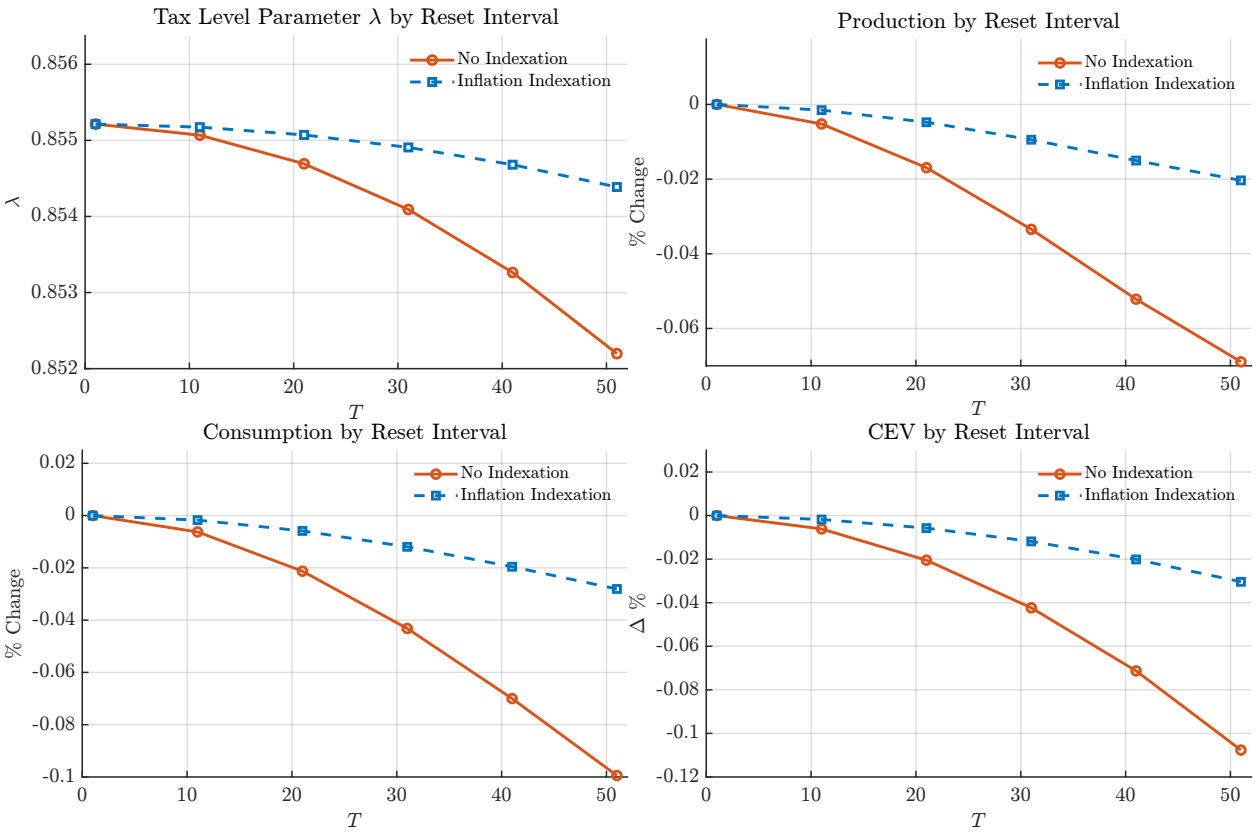
The remaining panels show the resulting macroeconomic and welfare effects. As T increases, the losses in cycle-average output and consumption become larger, and the consumption-equivalent welfare change becomes more negative. The deterioration is nonlinear: allowing the indexation gap to persist for additional periods becomes increasingly costly as the economy reaches phases with higher effective marginal tax rates and a more responsive tax base.

The effects are substantially larger under no automatic indexation than under inflation indexation. Under no automatic indexation, both inflation and trend real income growth widen the indexation gap between resets. Under inflation indexation, movements in the price level are incorporated into the nominal position of the tax schedule, so only trend real income growth generates the gap. Consequently, a given increase in T produces a wider range of effective tax rates and larger output, consumption, and welfare losses under no automatic indexation.

These results show that the economic consequences of imperfect indexation depend not only on the indexation rule but also on how long the resulting gap is allowed to persist. Even

inflation indexation does not fully stabilize effective tax rates when real incomes are growing. More frequent comprehensive adjustment of the tax schedule can therefore reduce the tax cycle, although only full nominal-income indexation eliminates it altogether.

Figure 5: Macroeconomic and welfare outcomes by reset interval



Note: Output and consumption are percentage changes in their cycle averages relative to full indexation. CEV is the consumption-equivalent welfare change, also expressed in percent. For each reset interval T and indexation regime, λ is adjusted so that average tax revenue equals g, and the government's net financial position satisfies $b_{T+1} = b_1$. At $T = 1$, the tax schedule is reset every period, so no within-cycle indexation gap arises.

4.4 Inflation, real growth, and the strength of the tax cycle

The benchmark output and welfare losses are relatively moderate, partly because inflation and real wage growth were modest during the Korean calibration period. More generally, the strength of the tax cycle depends on how rapidly trend nominal income grows relative to the nominal position of the tax schedule. Recall that the within-cycle indexation ratio evolves

according to the relative-growth factor

$$q \equiv \frac{\gamma(1+\pi)}{\Gamma},$$

where $\gamma(1+\pi)$ is the gross growth rate of trend nominal income and Γ is the gross growth rate of the nominal position of the tax schedule between reset dates. When $q > 1$, the indexation ratio s_j increases over the cycle and the indexation gap widens. A larger q causes effective average and marginal tax rates to rise more rapidly between resets.

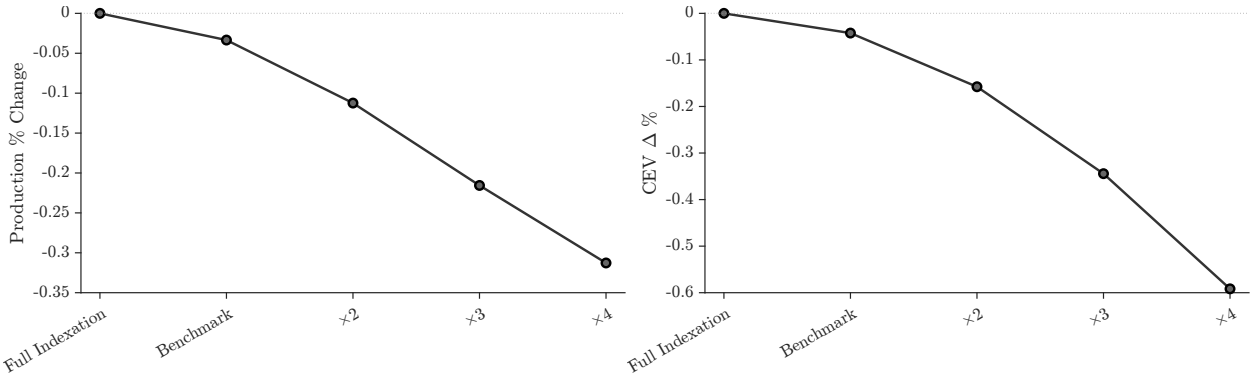
The determinants of q differ across indexation regimes. Under no automatic indexation, $\Gamma = 1$, so both inflation and trend real income growth widen the indexation gap. Under inflation indexation, $\Gamma = 1 + \pi$, so inflation is incorporated into the nominal tax schedule and $q = \gamma$; real income growth nevertheless continues to raise effective tax rates. Under full indexation, $\Gamma = \gamma(1 + \pi)$, implying $q = 1$, and neither inflation nor trend real growth generates a tax cycle.

Figure 6 quantifies the importance of nominal income growth under no automatic indexation. Starting from the benchmark calibration, we scale both the inflation rate and the trend real growth rate by factors of two to four. For each scenario, the figure reports the percentage change in cycle-average output and the consumption-equivalent welfare change under no automatic indexation, measured relative to full indexation under the same inflation and growth assumptions.

The reset interval remains fixed at $T = 31$, and β and χ are held at their benchmark values, with the general equilibrium recomputed in each scenario. In every scenario, λ under full indexation is chosen to match the benchmark average marginal tax rate, g is set equal to the resulting full-indexation tax revenue, and λ under no automatic indexation is adjusted so that both regimes raise the same cycle-total revenue.

Higher inflation and faster real growth both amplify the tax cycle under no automatic indexation. Each raises trend nominal income growth relative to the fixed nominal tax schedule,

Figure 6: Output and Welfare Losses under Alternative Nominal Growth Rates



Note: Each panel reports the percentage change in cycle-average output and the consumption-equivalent welfare change under no automatic indexation relative to full indexation under the same nominal growth assumptions. The reset interval is $T = 31$. The benchmark uses annual inflation of 1.69 percent and annual real growth of 1.84 percent; "$\times k$" scales both rates by a factor of k. β and χ are held at their benchmark values. For each scenario and regime, λ is adjusted to satisfy the common cycle-total revenue condition, and government net financial positions satisfy $b_{T+1} = b_1$.

causing the indexation gap and the within-cycle variation in effective tax rates to increase. The resulting stronger labor-supply response weakens the tax base, while the common revenue condition requires a higher overall level of effective tax rates. Both cycle-average output and welfare therefore decline by more than in the benchmark calibration.

These experiments show that the benchmark estimates are specific to the relatively moderate inflation and growth environment of the calibration period. The consequences of imperfect indexation can be substantially larger when nominal income grows more rapidly.

4.5 Tax progressivity and the cost of imperfect indexation

The strength of the tax cycle depends not only on how fast trend nominal income grows relative to the tax schedule, but also on how strongly a given indexation gap translates into higher effective tax rates. That translation is governed by the progressivity parameter τ.

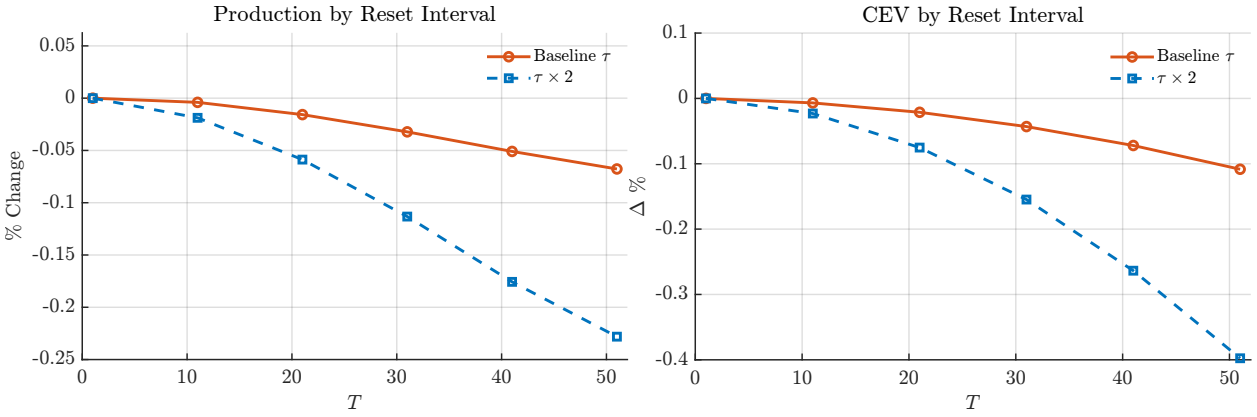
In Table 1, the countries that operate full nominal-income indexation are concentrated among the Nordic and Northern European economies, which generally levy relatively progressive personal income taxes.[9] If the welfare cost of imperfect indexation increases with

[9]Using the HSV specification, Holter et al. (2019) estimate the progressivity parameter τ at roughly

progressivity, these countries face a stronger incentive to adopt a comprehensive indexation rule.

Figure 7 evaluates this mechanism quantitatively by comparing the benchmark progressivity parameter τ with twice its benchmark value across alternative reset intervals T. Inflation and trend real growth remain at their benchmark values. For each value of τ, β and χ are recalibrated to preserve the benchmark targets for the net real interest rate and average hours. For each (τ, T) pair, λ is adjusted so that the common cycle-total revenue condition is satisfied.

Figure 7: Output and Welfare Losses by Reset Interval and Tax Progressivity



Note: The left panel reports the percentage change in cycle-average output and the right panel the consumption-equivalent welfare change, in each case under no automatic indexation relative to full indexation evaluated at the same value of τ. Inflation and trend real growth are at their benchmark values. For each τ, β and χ are recalibrated to the benchmark interest-rate and hours targets, g is set to full-indexation tax revenue under benchmark, λ is adjusted to satisfy the cycle-total revenue condition, and government net financial positions satisfy $b_{T+1} = b_1$.

Both output and welfare losses increase in magnitude with τ. Two forces reinforce each other. A higher τ raises the within-cycle dispersion of effective marginal tax rates, strengthening the variation effect associated with imperfect tax smoothing. It also strengthens the tax-base feedback: the larger induced labor-supply response weakens taxable income by more, so a larger downward adjustment in λ—a higher overall tax burden—is required to collect the same cycle-total revenue.

0.22–0.25 for the Northern European economies, compared with 0.137 for the United States and 0.101 for Japan.

Two qualifications are worth emphasizing. First, this exercise does not evaluate the desirability of progressivity itself. The redistributive and insurance benefits of a higher τ are not weighed here; the comparison is conditional on τ and concerns only the cost of failing to index a schedule of a given progressivity. Second, the association between progressivity and indexation practice in Table 1 is descriptive. Observed indexation rules also reflect national inflation histories, legislative procedures, and the administrative cost of frequent statutory revision. The model result should therefore be read as identifying one economic force that makes comprehensive indexation more valuable in a more progressive system, not as a complete explanation of the cross-country pattern.

4.6 Welfare consequences for hand-to-mouth households

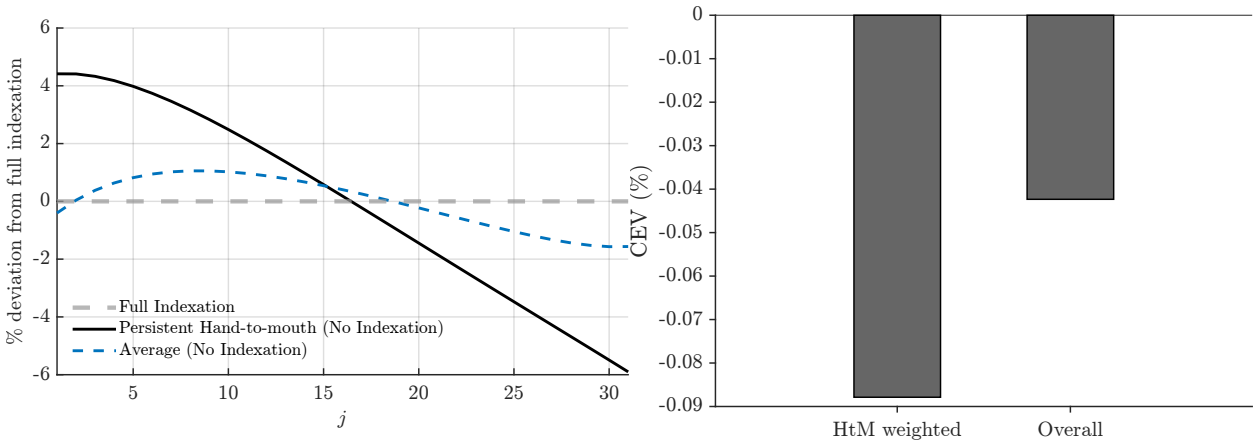
The aggregate effects discussed above do not fully capture how the tax cycle affects households with different capacities to smooth consumption. Imperfect indexation generates within-cycle fluctuations in disposable labor income. In a representative-agent model with unrestricted access to saving and borrowing, the household can largely smooth these anticipated income fluctuations, limiting their direct effect on consumption. In an incomplete-markets economy, however, households with little or no assets have much less scope to self-insure against such fluctuations (Kaplan and Violante, 2014; Kaplan et al., 2014). For these households, changes in disposable income pass more directly into consumption, creating an additional channel through which imperfect indexation lowers welfare.

A direct comparison of welfare across wealth groups is not straightforward for two reasons. First, each indexation regime has its own periodic stationary distribution of assets and productivity. A comparison of households at the same observed asset level across regimes may therefore compare groups with different productivity compositions and different equilibrium histories, rather than otherwise identical households facing different tax paths. Second, under imperfect indexation, the composition of the hand-to-mouth group changes over the tax cycle. Some households accumulate assets during the earlier, lower-tax phases and subsequently

draw them down as effective tax rates rise. They may therefore move into and out of the zero-asset group over the cycle. Consequently, the average consumption of households observed at $a = 0$ in different phases of the cycle does not trace the consumption path of a fixed set of households. It reflects both changes in individual consumption and changes in the composition of the zero-asset group. Comparisons based on wealth quantiles face a similar problem because the asset distribution contains a mass point at zero.

We therefore restrict attention to the group for which these composition effects are absent: *persistent* hand-to-mouth households. We define these as households who hold no assets ($a = 0$) and choose not to accumulate any ($a' = 0$) in every period j of the cycle, conditional on their labor productivity remaining unchanged. As long as productivity does not change, such a household remains hand-to-mouth throughout the entire cycle. Fixing both the productivity level and the (zero) asset position in this way allows us to track the consumption of the households that are unable to escape the hand-to-mouth state at any point in the cycle.[10]

Figure 8: Consumption and CEV of Hand-to-mouth Households



Note: Consumption streams are reported as percentage deviations from the Full Indexation benchmark. The persistent hand-to-mouth series is the weighted average of consumption policies across persistent hand-to-mouth states ($a = 0, \epsilon$), where each productivity level is weighted by its time-averaged share among persistent hand-to-mouth states; the Full Indexation series applies the same weights. CEV is computed as defined in Section 4.3; "HtM weighted" reports the weighted average CEV of persistent hand-to-mouth households, and "Overall" the economy-wide CEV.

[10]The share of hand-to-mouth households varies over the cycle, since households with low labor productivity but initially positive asset holdings deplete their assets during high-tax periods. Once a household becomes hand-to-mouth, however, it cannot escape this state without a positive labor productivity shock.

Figure 8 shows that consumption is substantially more volatile for persistent hand-to-mouth households than for the economy as a whole. Under no automatic indexation, their consumption rises above the full-indexation benchmark during the earlier, lower-tax phases but falls substantially below it during the later, higher-tax phases. Because these households remain at zero assets, they cannot save part of their relatively high disposable income early in the cycle and use it to support consumption later. The tax-induced variation in disposable income therefore passes more directly into consumption, resulting in a larger consumption-equivalent welfare loss for these households than the economy-wide average.[11]

5 Conclusion

This paper identifies imperfect indexation as a source of a recurring tax cycle. When nominal taxable income grows faster than nominal tax-bracket thresholds, effective average and marginal tax rates rise even without changes in statutory tax rates. Subsequent adjustments of the tax schedule lower these rates, generating tax-rate variation that is unrelated to changes in government expenditure or other underlying fiscal needs.

In a heterogeneous-agent model, imperfect indexation reduces welfare through both greater within-cycle variation in effective marginal tax rates and a tax-base feedback that raises the overall tax burden required to collect the same total revenue. The benchmark aggregate losses are moderate, but become larger when nominal income grows more rapidly, the indexation gap is allowed to persist for longer, or the labor-income tax schedule is more progressive. Inflation indexation eliminates the inflation-driven component of the tax cycle but not the component generated by trend real income growth. Welfare losses are also larger for hand-to-mouth households, which have limited capacity to smooth the resulting fluctuations in disposable income.

[11]The "HtM weighted" CEV is computed from the value functions $V_j(0, \epsilon)$, which incorporate expectations over future productivity changes; it therefore does not assume that these households remain hand-to-mouth forever. Exit is nevertheless unlikely in the short run: productivity is persistent, and because $a'_j(0, \epsilon) = 0$, a household remains at zero assets for at least one more period.

Several extensions remain for future research. The current model represents prolonged incomplete indexation through a deterministic periodic adjustment. Allowing legislative changes to be uncertain, partial, or endogenous to fiscal conditions would provide a more realistic description of actual tax policy. Unequal productivity growth across income groups could also have important implications for the design of an indexation rule based on average earnings. Introducing aggregate shocks would permit an analysis of the interaction between indexation and the automatic-stabilization role of progressive taxation. Finally, a richer household balance sheet with separate liquid and illiquid assets could provide a more detailed account of how the tax cycle affects households with limited short-run self-insurance.

References

Aiyagari, S. R. (1994). Uninsured idiosyncratic risk and aggregate saving. *Quarterly Journal of Economics 109*(3), 659–684.

Balasundharam, V., A. Kayastha, and M. Poplawski-Ribeiro (2023). Inflation indexation in public finances: A global dataset on current practices. IMF Working Paper WP/23/264, International Monetary Fund.

Balladares, S. and E. García-Miralles (2026). Fiscal drag with microsimulation: Evidence from Spanish tax records. *Fiscal Studies*, 1–25.

Barro, R. J. (1979). On the determination of the public debt. *Journal of Political Economy 87*(5), 940–971.

Beer, S., M. Griffiths, and A. Klemm (2023). Tax distortions from inflation: What are they? how to deal with them? IMF Working Paper 23/18, International Monetary Fund.

Bhattarai, S., J. W. Lee, W. Y. Park, and C. Yang (2026). Financing capital tax cuts: Aggregate, distributional, and welfare effects. *Working Paper*.

Bhattarai, S., J. W. Lee, and C. Yang (2023). Redistribution and the Monetary–Fiscal Policy Mix. *Quantitative Economics 14*(3), 817–853.

Bianchi, F., R. Faccini, and L. Melosi (2023). A Fiscal Theory of Persistent Inflation. *Quarterly Journal of Economics 138*(4), 2127–2179.

Bianchi, F. and L. Melosi (2017). Escaping the Great Recession. *American Economic Review 107*(4), 1030–1058.

Blanchet, T., J. Fournier, and T. Piketty (2022). Generalized Pareto curves: Theory and applications. *Review of Income and Wealth 68*(1), 263–288.

Chari, V. V., L. J. Christiano, and P. J. Kehoe (1994). Optimal fiscal policy in a business cycle model. *Journal of Political Economy 102*(4), 617–652.

Dorn, F., C. Fuest, B. Kauder, L. Lorenz, M. Mosler, N. Potrafke, and L. Dörr (2017). How bracket creep creates hidden tax increases: Evidence from Germany. *ifo DICE Report 15*(4), 34–39.

Garcia-Macia, D. (2023). The effects of inflation on public finances. IMF Working Paper WP/23/93, International Monetary Fund.

García-Miralles, E., M. Freier, S. Riscado, et al. (2026). Fiscal drag in theory and in practice: A European perspective. *European Economic Review 185*, 105275.

Hack, L. (2025). Progressive income taxation and inflation: The macroeconomic effects of bracket creep. Working paper, University of Mannheim and ETH Zürich.

Han, J., J. Woo, and J. H. Hong (2018). *Macroeconomic Effects of Income Redistribution Policy: A Heterogeneous Agent Model Analysis*. Research Report. Sejong, Korea: Korea Institute of Public Finance. In Korean. Original title: 소득 재분배 정책의 거시 경제적 효과: 이질적 경제 주체 모형 분석.

Heathcote, J., K. Storesletten, and G. L. Violante (2017). Optimal tax progressivity: An analytical framework. *Quarterly Journal of Economics 132*(4), 1693–1754.

Heer, B. and B. Süssmuth (2013). Tax bracket creep and its effects on income distribution. *Journal of Macroeconomics 38*, 393–408. Part B.

Heinemann, F. (2001). After the death of inflation: Will fiscal drag survive? *Fiscal Studies 22*(4), 527–546.

Holter, H. A., D. Krueger, and S. Stepanchuk (2019). How do tax progressivity and household heterogeneity affect Laffer curves? *Quantitative Economics 10*(4), 1317–1356.

Kaplan, G. and G. L. Violante (2014). A model of the consumption response to fiscal stimulus payments. *Econometrica 82*(4), 1199–1239.

Kaplan, G., G. L. Violante, and J. Weidner (2014). The wealthy hand-to-mouth. *Brookings Papers on Economic Activity 45*(1), 77–138.

Keinsley, A. (2016). Indexing the income tax code, monetary/fiscal interaction, and the great moderation. *European Economic Review 89*, 1–20.

King, R. G., C. I. Plosser, and S. T. Rebelo (1988). Production, growth and business cycles: I. the basic neoclassical model. *Journal of Monetary Economics 21*(2–3), 195–232.

Leeper, E. M. (1991). Equilibria under 'active' and 'passive' monetary and fiscal policies. *Journal of Monetary Economics 27*(1), 129–147.

OECD (2023). *Taxing Wages 2023: Indexation of Labour Taxation and Benefits in OECD Countries*. Paris: OECD Publishing.

Rouwenhorst, K. G. (1995). Asset pricing implications of equilibrium business cycle models. In T. F. Cooley (Ed.), *Frontiers of Business Cycle Research*, pp. 294–330. Princeton, NJ: Princeton University Press.

Sanz-Sanz, J. F. and M. Arrazola (2025). Unveiling the bracket creep: Static versus dynamic fiscal drag. *Journal of Economics 146*(3), 443–475.

Sims, C. A. (1994). A simple model for study of the determination of the price level and the interaction of monetary and fiscal policy. *Economic Theory 4*(3), 381–399.

Werning, I. (2007). Optimal fiscal policy with redistribution. *Quarterly Journal of Economics 122*(3), 925–967.

Zhu, J. (2014). Bracket creep revisited—with and without $r > g$: Evidence from Germany. *Journal of Income Distribution 23*(3), 106–158.

Appendix

A. Progressive Taxation of Total Income

In the benchmark model, the progressive HSV schedule applies to labor income only, while capital income is taxed separately at the flat rate τ_k. This appendix considers the alternative in which the progressive schedule is levied on total income, so that labor and capital income are aggregated into a single tax base.

Let nominal total taxable income be

$$Y_t = P_t W_t e^{\epsilon_t} n_t + P_t r_t A_t,$$

and let disposable income be given by the same schedule as in Equation (1), evaluated at this broader base. The household budget constraint becomes

$$P_t C_t + P_t A_{t+1} = D_t(Y_t) + P_t A_t,$$

or, in detrended form,

$$c + \gamma a' = d_j(w_j e^{\epsilon} n + r_j a) + a,$$

where $d_j(\cdot)$ is defined as in Equation (2). The effective average and marginal tax rates in Equations (3)–(4) are unchanged in form, but are now evaluated at total rather than labor income.

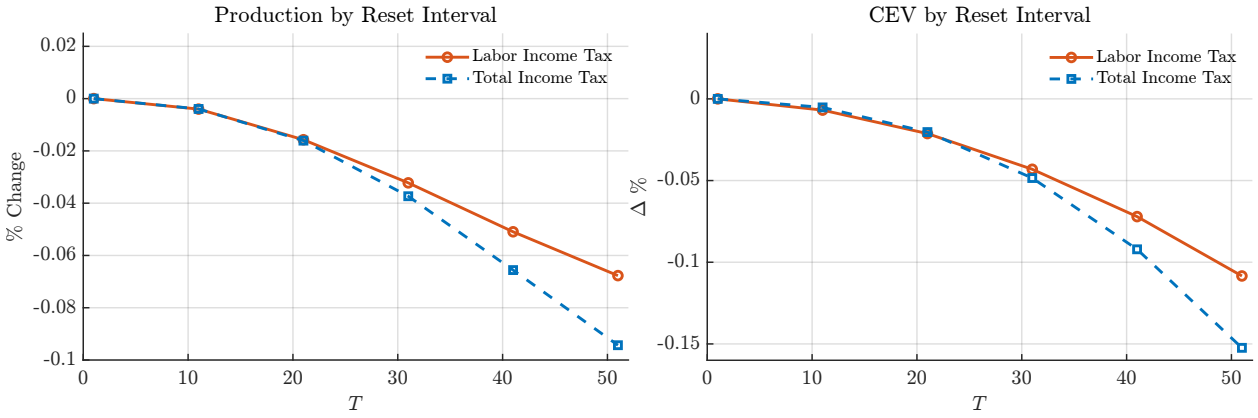
The economic content of the tax cycle is correspondingly broader. Under imperfect indexation, the rising indexation ratio s_j now raises the effective marginal tax rate applied to *both* labor and capital income. Fiscal drag therefore distorts the intertemporal margin in addition to the labor-supply margin: the after-tax return to saving falls as the cycle progresses, and households anticipate this decline.

The specification is recalibrated so that it remains comparable to the benchmark. The

progressivity parameter τ is held at its benchmark value; β and χ are chosen to reproduce the benchmark targets for the net real interest rate and average hours under full indexation; g is set equal to the tax revenue raised in the benchmark full-indexation equilibrium, in which the progressive schedule applies to labor income only; and, in each regime, λ is adjusted so that the cycle-total revenue condition (9) holds, with the government's net financial position satisfying $b_{T+1} = b_1$.

Figure 9 reports the results. The patterns are qualitatively the same as in the benchmark specification: cycle-average output and welfare losses relative to full indexation grow as the reset interval widens, and the losses are somewhat larger under total-income taxation at longer reset intervals. The main conclusions of the paper are therefore not driven by the assumption that progressive taxation applies to labor income alone.

Figure 9: Output and Welfare Losses under Progressive Taxation of Total Income



Note: The progressive HSV schedule is applied to total income, that is, the sum of labor and capital income. The left panel reports the percentage change in cycle-average output and the right panel the consumption-equivalent welfare change, in each case relative to full indexation. For each regime, λ is adjusted so that $\sum_{j=1}^{T} R_j = Tg$, and the government's net financial position satisfies $b_{T+1} = b_1$.