

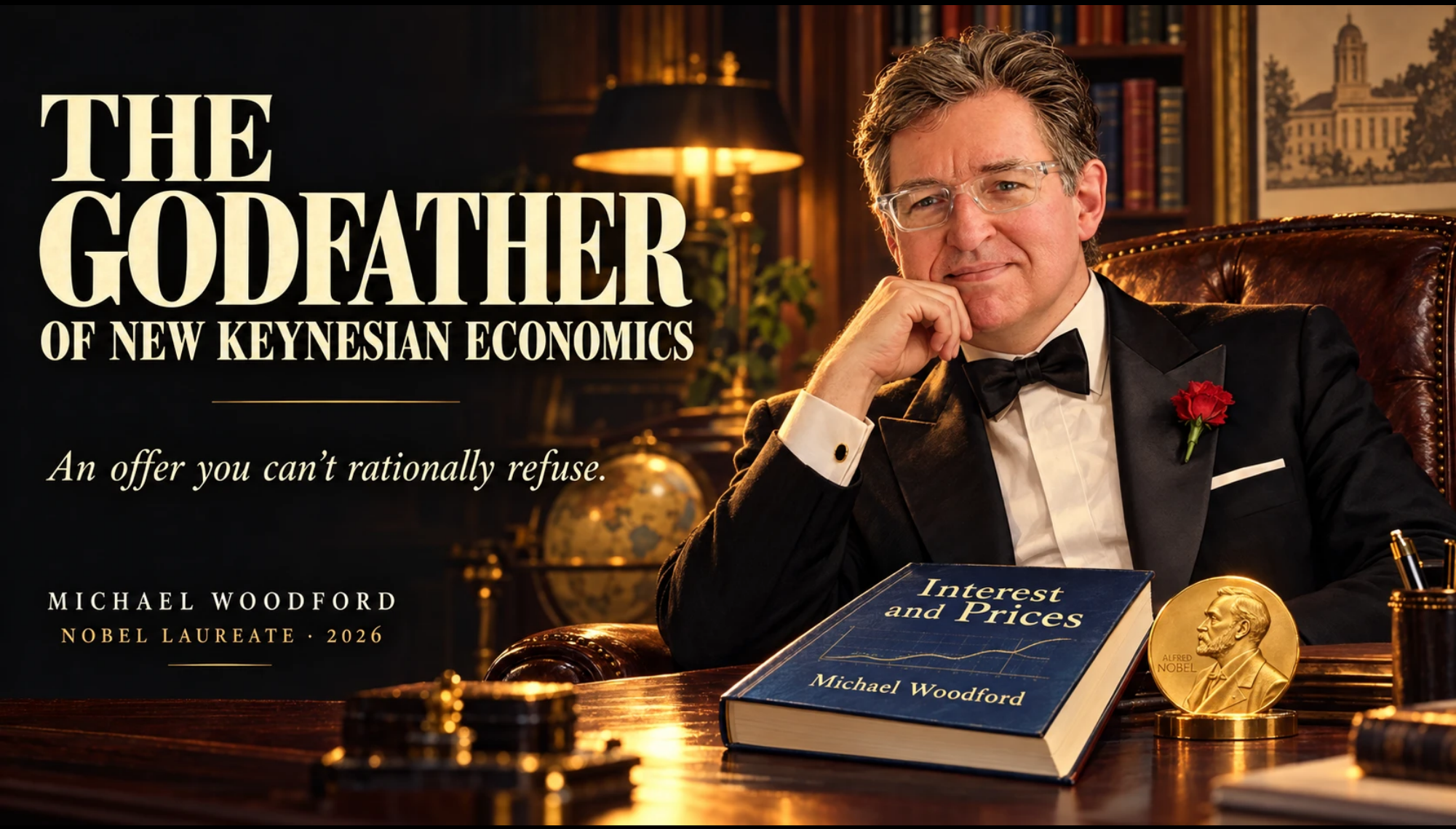
BROWN

Mike Woodford, Markups, and Monetary Policy

Drawing on an unfinished project with Mike Woodford, *Flexible Inflation Targeting as Optimal Stabilization Policy*

Gauti B. Eggertsson
Brown University

Discussion · Federal Reserve Bank of New York · 16 October 2026


THE
GODFATHER
OF NEW KEYNESIAN ECONOMICS
An offer you can't rationally refuse.
MICHAEL WOODFORD
NOBEL LAUREATE · 2026
Interest and Prices
Michael Woodford
ALFRED NOBEL

Congratulations to Mike Woodford and Bob Hall!

Three of Mike's central contributions.

1. **The canonical New Keynesian model**

$$\begin{aligned}
&\text{IS} && x_t = \mathbb{E}_t x_{t+1} - \sigma\left(\widehat{\imath}_t - \mathbb{E}_t \pi_{t+1} - \widehat{r}^e_t\right) \\
&\text{NK PC} && \pi_t = \kappa x_t + \beta \mathbb{E}_t \pi_{t+1} + \kappa_\mu \left(\widehat{Y}^e_t - \widehat{Y}^n_t\right) \\
&\text{OBJ} && \mathbb{E}_{t_0} \textstyle\sum_{t \geq t_0} \beta^{t-t_0} \left[\pi_t^2 + \lambda (x_t - x^*)^2\right] \\
&\text{PR} && \widehat{\imath}_t = \widehat{r}^n_t + \phi_\pi \pi_t + \phi_x x_t \\
& && x_t \equiv \widehat{Y}_t - \widehat{Y}^e_t, \qquad \lambda = \kappa/\theta
\end{aligned}$$

} policy minimizes the objective, *or* follows a reaction function

2. **Monetary policy without money supply** Woodford (1998)

3. **Medium-scale DSGE model**

Rotemberg and Woodford (1997) $\longrightarrow$ Christiano, Eichenbaum and Evans (2005) $\longrightarrow$ Smets and Wouters (2007)

Four questions about rising markups

Q1. A flatter Phillips curve? Different transmission?

Q2. A different inflation–output tradeoff?

Q3. A lower natural rate?

Q4. Weak investment despite high valuations?

Three extensions of the NK model in my work in progress with Mike:

1. **Multiple industries** Q1, Q2
2. **State-dependent pricing** Q1, Q2
3. **Heterogeneous household income** Q2

Q3 at the end, across all three. Q4 lies outside them; a short comment at the end.

The industry model

Goods	industries $j \in [0,1]$, suppliers i within each, nested CES
Demand	$Y_t^j = Y_t \left(P_t^j / P_t\right)^{-\theta^I}, \quad Y_t^{ji} = Y_t^j \left(P_t^{ji} / P_t^j\right)^{-\theta^F}$
Household	representative; $u(C_t) - \int_0^1 v(L_t^j)\, dj$
Labor	$Y_t^{ji} = L_t^{ji}$; a competitive labor market per industry, wage w_t^j
Pricing	Calvo by industry, probability $1 - \alpha$
Sync	all i in j reset together: $P_t^{ji} = P_t^j$
Markup	$\dfrac{P_t^{ji}}{P_t} = \dfrac{\theta^F}{\theta^F - 1} \dfrac{w_t^j}{1 + s_t}$
Rest	ξ_t, s_t, $\widehat{\imath}_t$ rule: canonical

Which supplier? θ^F. **Which industry? θ^I.**

One elasticity does two jobs. Must it?

Standard model

The same elasticity determines markups and monetary stabilization.

$$\mu = \frac{\theta}{\theta - 1}, \qquad \frac{d\kappa}{d\mu} > 0, \qquad \frac{d\lambda}{d\mu} > 0.$$

Two elasticities

Within an industry, θ^F Between industries, θ^I

$$\underbrace{\mu^F = \frac{\theta^F}{\theta^F - 1}}_{\text{markup}} \qquad \underbrace{\kappa^I = \frac{(1-\alpha)(1-\alpha\beta)(\sigma^{-1}+\omega)}{\alpha\left(1+\omega\theta^I\right)}}_{\text{Phillips slope}} \qquad \underbrace{\tilde{\pi}_t^2 + \lambda^I x_t^2}_{\text{period objective}}$$

$$\frac{d\kappa^I}{d\mu^F} = 0 \qquad \lambda^I \equiv \frac{\kappa^I}{\theta^I}, \qquad \frac{d\lambda^I}{d\mu^F} = 0$$

How much does the distinction matter?

Small markups can coexist with a large output weight.

	Standard	Two elasticities
	$\theta = 10.5$	$\theta^F = 10.5$, $\theta^I = 1.24$
Desired firm markup	1.105	1.105
Phillips slope	0.022	0.115
Output weight, annual	0.034	**1.480**

Elasticities common in the literature; Edmond, Midrigan and Xu (2015).

$$\tilde{\pi}_t + \frac{1}{\theta^I}\left(x_t - x_{t-1}\right) = 0$$

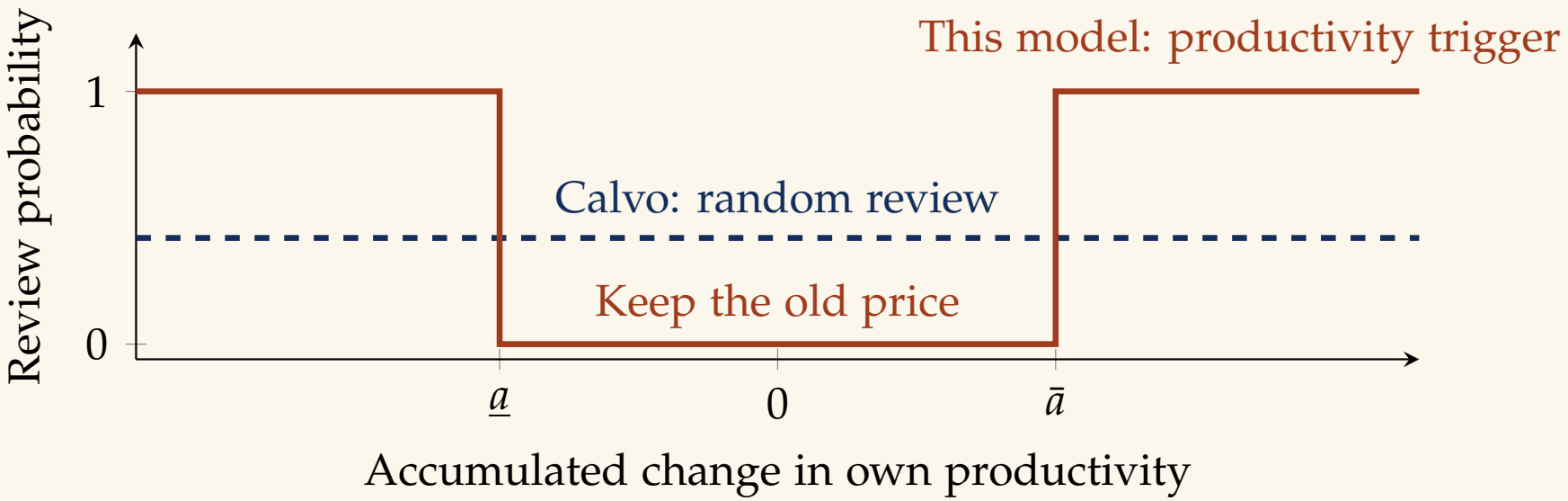
As substitution between industries approaches one, the target approaches nominal GDP stabilization.

The pricing model

Goods	CES over $j \in [0,1]$, elasticity θ
Supply	$N_t^j = Y_t^j / A_t^j$, own effort, disutility $v(N_t^j)$
Insurance	$C_t^j = C_t$
Productivity	$\Delta a_t^j = 0$ w.p. $1-\xi$, $\quad \Delta a_t^j \sim U[\underline{w}, \bar{w}]$ w.p. ξ
Exit	δ; entrant $a_t^j = 0$
Information	a_t^j free; aggregates and P_t^{*j}: fixed cost
Review	$a_t^j - a_k^j \notin [\underline{a}, \bar{a}]$ (k: last review) $\Rightarrow$ $P_t^j = P_t^{*j} = (A_t^j)^{-\psi} P_t^*$
Otherwise	$P_t^j = P_{t-1}^j$
Rest	ξ_t, s_t, $\widehat{\imath}_t$ rule: canonical

The trigger is the firm's own cost, not a random draw.

When does a firm review its price?



Who keeps an old price? Under Calvo, a random draw. Here, the firm whose cost has barely moved.

Same share of stale prices every quarter as under Calvo; different prices:

$$\alpha = \underbrace{(1-\delta)}_{\text{survives}} \Big[\underbrace{1-\xi}_{\text{no cost change}} + \underbrace{\xi\gamma}_{\text{change inside the band}} \Big]$$

A stale price with a changed cost is a changed markup.

What does the review rule change?

Unchanged: desired markup, natural rate, output weight κ/θ, and the slope itself,

$$\kappa = \frac{(1-\alpha)(1-\alpha\beta)}{\alpha}\,\frac{\sigma^{-1}+\omega}{1+\omega\theta}, \qquad \alpha = (1-\delta)[1-\xi+\xi\gamma].$$

	Canonical	State-dependent review
Stale prices	a random draw	markups inside the band
Realized markups	dispersion is the loss	misalignment with cost is the loss
Phillips curve	slope κ	slope κ, plus the composition of stale prices
Optimal policy	$\tilde{\pi}_t + (x_t - x_{t-1})/\theta = 0$	$\tilde{\pi}_t + (x_t - x_{t-1})/\theta = \tau_t$

τ_t is zero after a markup shock and nonzero only when stale prices must be realigned with costs.

Inflation misaligns markups with costs. Policy realigns them.

Households and markets

Groups differ in income exposure and fixed profit claims:

$$j_t(g,i) = \underbrace{\eta_g y_t}_{\text{income exposure}} + \underbrace{\zeta_g D_t}_{\text{profit claims}} + e_t(g,i).$$

Preferences and work

Common CRRA preferences, linear hours disutility.
Canonical union wage and employment rule.

Markets

One bond, unrestricted borrowing and saving.
Fixed profit claims, no insurance against aggregate income news.

Firms

Canonical Calvo pricing. D_t: net profits relative to reference output.

Relative permanent-income news remains uninsured.

Who receives the profits?

At fixed output, a higher realized markup raises profits.

$$\boxed{\mathcal{L} = \tfrac{1}{2}\,\mathbb{E}\sum_t \beta^t \left[\pi_t^2 + \lambda\left(x_t^2 + a\,\mathrm{Var}_g(m_t)\right)\right]} \qquad \lambda = \frac{\kappa}{\theta}, \quad a = \frac{\sigma^{-1}}{\sigma^{-1}+\omega}$$

$m_t(g)$: consumption of group g; its dispersion is set at impact and then stays.

Shock at the reference date, aggregate income held fixed; y^P, D^P the annuity values of output and profits it creates. For every $t \geq 0$:

$$\frac{\partial\,\mathrm{Var}_g(m_t)}{\partial \widehat{\mu}^P} = \frac{2}{1+\omega}\left[\mathrm{Cov}_g(\eta_g, \zeta_g)\, y^P + \mathrm{Var}_g(\zeta_g)\, D^P\right]$$

$$y^P < 0, \qquad D^P > 0, \qquad \mathrm{Cov}_g(\eta_g, \zeta_g) < 0 \quad \Longrightarrow \quad \frac{\partial\,\mathrm{Var}_g(m_t)}{\partial \widehat{\mu}^P} > 0.$$

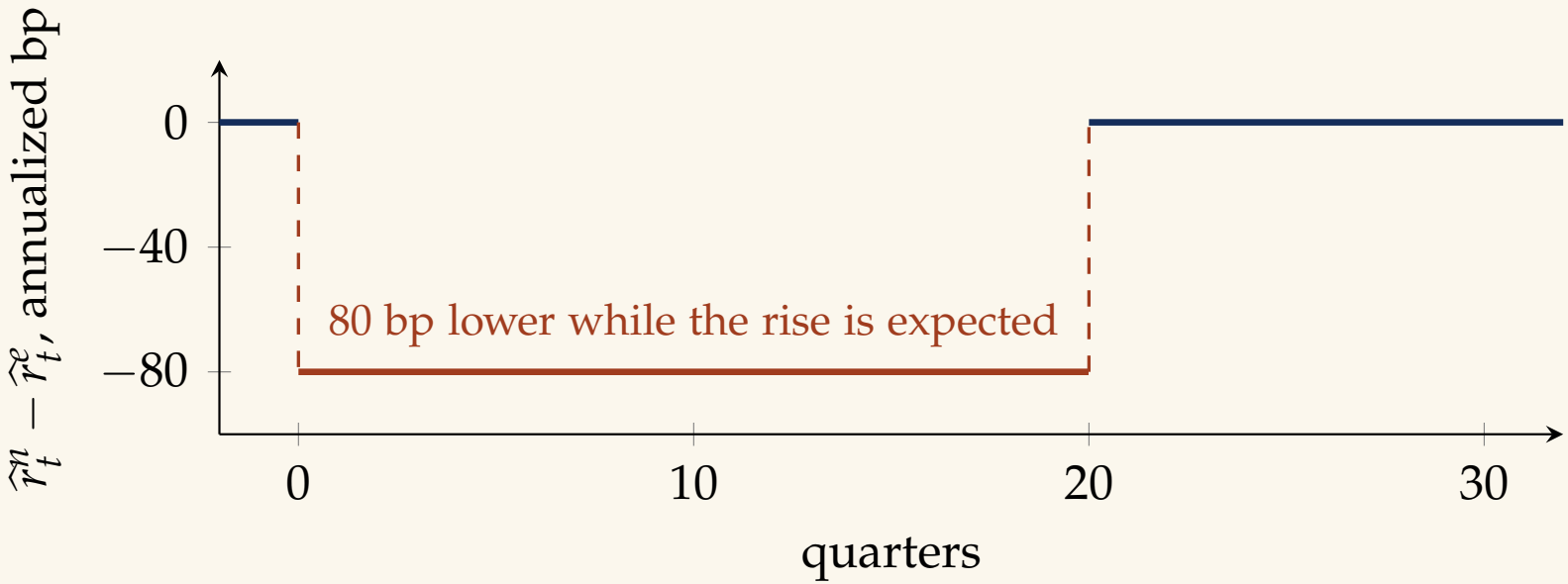
Those hit hardest receive less of the profit increase.

The plausible case: profit redistribution amplifies consumption gaps.

Does a rising markup lower the natural rate?

All three

$$\widehat{Y}_t^n = \widehat{Y}_t^e - \frac{\widehat{\mu}_t}{\sigma^{-1}+\omega} \quad \Longrightarrow \quad \boxed{\widehat{r}_t^n - \widehat{r}_t^e = -\frac{\sigma^{-1}}{\sigma^{-1}+\omega}\,\mathbb{E}_t\,\Delta\widehat{\mu}_{t+1}}$$



Markup announced to rise from 20% to 30% over 20 quarters; $\sigma^{-1} = \omega = 1$.

Lower natural output is a level effect. The natural rate falls while further markup increases are expected.

Four answers

Q1. **Phillips curve.** Markups alone do not identify its slope. A stale price with a changed cost is a changed markup, so who reviews prices matters for transmission.

Q2. **Policy tradeoff.** Small markups can coexist with a large output weight, forty times larger with the between-industry elasticity. The markup-shock target survives state-dependent pricing. In the plausible ownership case, profit redistribution amplifies consumption dispersion.

Q3. **Natural rate.** It falls while further markup increases are expected, not with the level. Eggertsson and Mehrotra (unpublished) find that aging raises markups and lowers interest rates together.

Q4. **Investment and valuations.** Outside these extensions. Eggertsson, Robbins and Wold (JME 2021) rationalize the missing investment boom at low rates by the rise in markups.

The level of the markup identifies none of this. Its source does.

Backup 1. Two comparison conventions, two inflation conventions

Industry note, Section 5

Assumes common price resetting within an industry and industry-specific labor markets.

Replacing the single elasticity θ^F by the between-industry θ^I with primitives $(\alpha, \beta, \sigma^{-1}, \omega)$ fixed:

$$\frac{\lambda(\theta^I)}{\lambda(\theta^F)} = \frac{\theta^F\left(1+\omega\theta^F\right)}{\theta^I\left(1+\omega\theta^I\right)} = 43.5 \qquad \frac{1/\theta^I}{1/\theta^F} = \frac{\theta^F}{\theta^I} = 8.47$$

Holding the slope κ fixed instead, the weight ratio is also 8.47 (one way: raise α from 0.75 to 0.88).

With annualized inflation $\tilde{\pi}_t^a = 4\tilde{\pi}_t$ given unit weight:

$$\lambda^a = 16\lambda, \qquad \tilde{\pi}_t^a + \frac{4}{\theta^I}\left(x_t - x_{t-1}\right) = 0.$$

Same 100 bp (annualized) cost-push shock, fresh commitment: impact output gap -0.21% nested versus -1.63% one-elasticity; impact inflation 69 versus 62 bp. Equal u_0 is equal reduced-form pressure, not an equal primitive markup shock.

Backup 2. When does actual inflation have a scalar Phillips curve under Ss pricing?

Pricing note, Sections 4.3–4.4

Retention $\alpha = (1-\delta)[1-\xi+\xi\gamma]$ is constant, but the productivity composition of a price-age cohort changes with age. Composition-adjusted inflation obeys the standard relation:

$$\tilde{\pi}_t - \chi_0 V_t \;=\; \beta\,\mathbb{E}_t\left[\tilde{\pi}_{t+1} - \chi_0 V_{t+1}\right] + \kappa\,(\widehat{Y}_t - \widehat{Y}_t^n), \qquad V_t = \sum_{j,k\geq 0} q_C^j q_0^k\,\mathbb{E}_t G_{t+j+k}.$$

Actual inflation obeys it for all admissible forcing if and only if

$$\chi_0 = 0 \iff (E_u - 1)\,\xi\gamma = 0, \qquad E_u = \frac{e^{-(1+\omega)\underline{a}} - e^{-(1+\omega)\bar{a}}}{(1+\omega)(\bar{a}-\underline{a})}.$$

- Symmetric band: $E_u > 1$, optimal trend inflation slightly negative, correction nonzero.
- Asymmetric band (small cost increases trigger review, large cost decreases do not): output response to a policy easing 25–35% larger than the scalar comparator at persistence 0.90–0.95.
- Pure markup-wedge disturbances: the canonical target remains exactly optimal (fresh commitment, no inherited distortion).

Backup 3. Unequal income exposure and a markup shock

Household note, Sections 4–6

Two groups, income elasticities $\eta^v > 1 > \eta^s$, a common bond, no insurance of relative income. Relative consumption is a martingale: it moves only with permanent-income *news*.

$$\mathcal{L} = \tfrac{1}{2}\,\mathbb{E}\sum_t \beta^t \left[x_t^2 + \lambda_c\,(\widehat{C}_t^v - \widehat{C}_t^s)^2 + \tfrac{\theta}{\kappa}\pi_t^2 \right],$$

$$\pi_t = \beta \mathbb{E}_t \pi_{t+1} + \kappa x_t + \underbrace{\kappa\lambda_c(\eta^v - \eta^s)}_{\kappa_c}\,(\widehat{C}_t^v - \widehat{C}_t^s) + u_t.$$

Cost-push shock $u_{t_0} = 0.01\kappa$, persistence 0.75 ($\lambda_c = 1/6$, $\eta^v - \eta^s = 0.5$, $\theta = 10$):

Policy	Gap (%)	Inflation (bp, annual)	$\widehat{C}^v - \widehat{C}^s$ (%)
Union optimum	-0.270	10.79	-0.0131 (permanent)
Reduced-form optimum	-0.270	10.83	-0.0136

The markup-shock prescription barely moves. What changes is who bears the contraction: the permanent-income news falls on the more exposed group, permanently. Dividends are equal across groups by assumption, so the labor-share channel of rising markups is switched off here.

Backup 4. Question 4 is outside the three extensions

Only if time permits; not part of the project with Woodford

All three extensions keep $Y_t = L_t$ and $C_t = Y_t$: no capital, no investment, no entry decision, no valuation.

What Question 4 needs

- Capital and a Tobin's Q
- A profit share that accrues to someone
- Entry and exit that respond to rents

Eggertsson, Robbins and Wold (2021): rising markups, falling investment, rising Q, falling r^*, in one model.

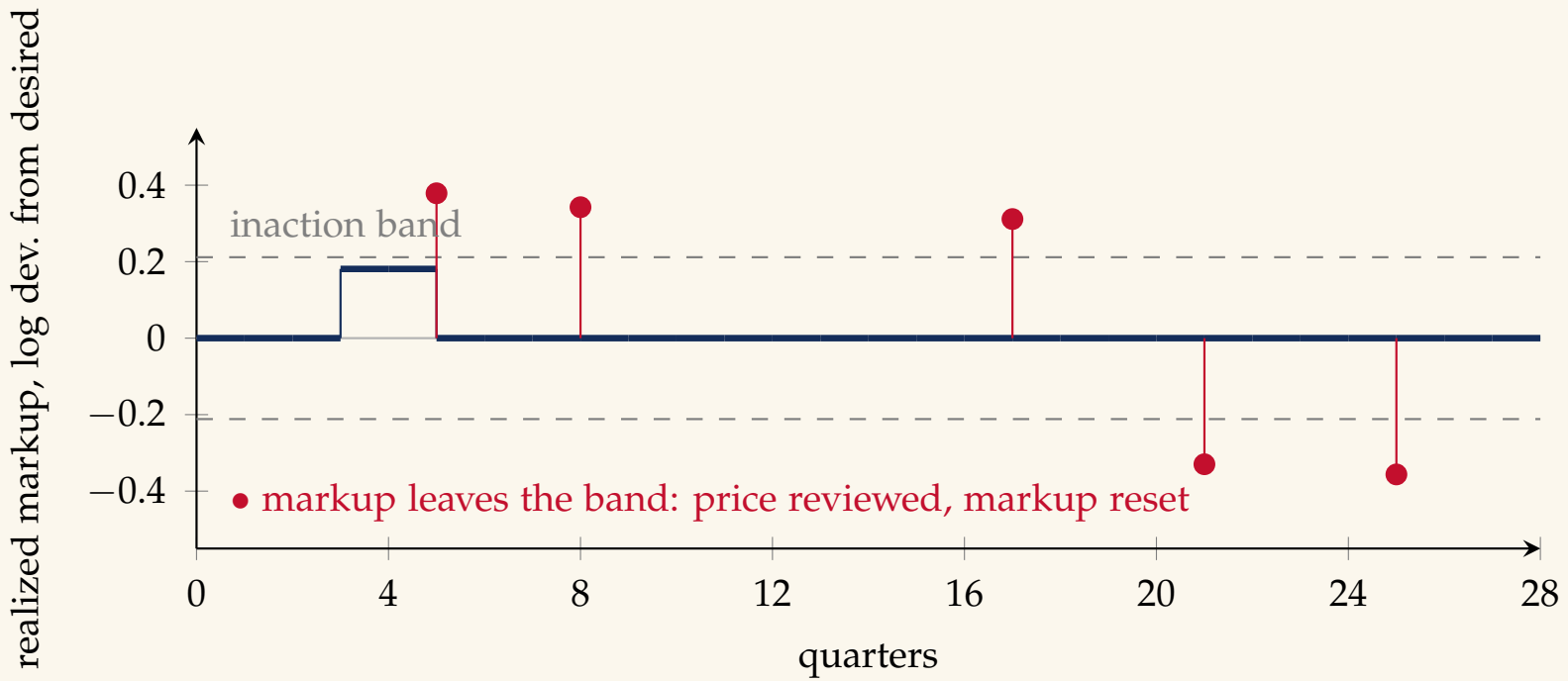
What extension 2 does say about turnover

- Exit δ and the shock frequency ξ govern when prices are reviewed.
- The productivity composition of surviving prices enters welfare at first order.
- Turnover matters for monetary welfare through price alignment, even without investment.

The three extensions are about nominal rigidities. Investment and dynamism are a different paper.

Backup 5. One firm's realized markup under the review rule

Simulated at the pricing note's calibration.



- Own productivity drifts in jumps; the firm's realized markup drifts with it.
- Review when the markup leaves the band; a review costs attention to aggregate conditions.
- A fixed share of prices is reviewed each quarter, as in Calvo; which ones depends on markups.

Backup 6. Household assumptions

A continuum of permanent groups $g \in [0,1]$, differing only in:

1. Exposure to aggregate income, η_g.
2. Fixed profit claims, ζ_g.

$$j_t(g,i) = \eta_g y_t + \zeta_g D_t + e_t(g,i), \qquad \mathbb{E}_g \eta_g = 1, \quad \mathbb{E}_g \zeta_g = 0.$$

Preferences and work
Common CRRA preferences; linear hours disutility. Canonical union wage and employment rule.

Markets
One bond, unrestricted borrowing and saving. Fixed, nontraded profit claims. No securities contingent on aggregate states.

Firms and profits. Canonical Calvo firms and technology, with curvature $\omega \geq 0$. D_t is the deviation of net profits $\Pi_t^N = Y_t - w_t L_t$, divided by reference output.

Individual risk. $e_t(g,i)$ is small, additive and iid, with a fixed law independent of aggregate conditions and policy; $\mathbb{E}_i[e_t \mid g] = 0$. Inherited wealth is fixed.

Local reference. Efficient output, equal consumption and zero steady bonds. Fixed transfers offset reference profit-income differences. Deviations use reference output.

Relative permanent-income news remains uninsured.