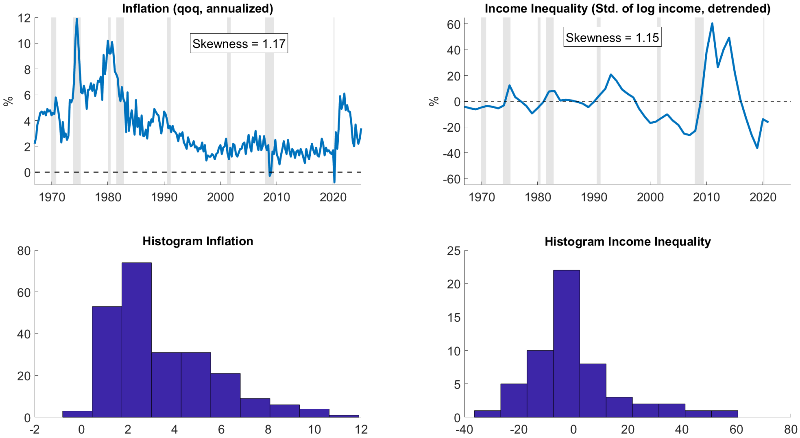
Inflation, Inequality, and the Business Cycle

Clara Lindemann Sofia Semik Mathias Trabandt

Motivation: U.S. Inflation and Inequality Data



- Inflation and income inequality are positively skewed

Inequality Data

What We Do

How can we account *jointly* for the skewness in inflation and inequality?

- Standard linearized New Keynesian models have difficulties to explain the positive skewness observed in the data
- We introduce a nonlinear **Phillips curve with state-dependent slope** into a **HANK model** to account for these data features
- The state-dependent slope Phillips curve is crucial to account **jointly** for the properties of inflation and inequality observed in the data
- Over the business cycle, inflation and income inequality increase more strongly than they decrease

Literature

- **Relationship between inequality, inflation and monetary policy:**

  Kaplan, Moll and Violante (2018), Auclert (2019), Auclert et al. (2023), Acharya, Challe and Dogra (2023), Bilbiie (2024), Auclert, Rognlie and Straub (2024)

  → Contribution: Introduce state-dependent nonlinear Phillips curve to account for skewness in inflation and inequality

- **Nonlinearities in the Phillips curve:**

  Harding, Linde and Trabandt (2022, 2023), Benigno and Eggertsson (2023), Gasteiger and Grimaud (2023), Forbes, Gagnon and Collins (2021), Schmitt-Grohe and Uribe (2022)

  → Contribution: Study implications on income inequality

Model

- Starting point: Nonlinear HANK model as in e.g. Auclert, Rognlie and Straub (2024)
  - Flexible prices and (Rotemberg) sticky wages
  - **Extension: Nonlinear Phillips curve with state-dependent slope**
  - Countercyclical inequality and income risk

- Households:

$$\max \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{c_{i,t}^{1-\sigma}}{1-\sigma} - \varphi \frac{n_{i,t}^{1+\nu}}{1+\nu} \right)$$

$$\text{s.t.} \quad c_{i,t} + a_{i,t} \leq (1-\tau_t) \underbrace{(w_t n_{i,t} e_{i,t} + d_{i,t})}_{\text{Labor+Dividend Income}} + \underbrace{(1+r_t) a_{i,t-1}}_{\text{Asset Income}}$$

$$a_{i,t} \geq \underline{a}.$$

  - $e_{i,t}$: Idiosyncratic, type-specific productivity
  - $a_{i,t}$: Type-specific asset stock

Model: Countercyclical Inequality

- Labor allocation rule following Auclert and Rognlie (2018):

$$n_{i,t} = n_t \frac{e_{i,t}^{\zeta_n ln(n_t/n)}}{\mathbb{E}\left[e_i^{1+\zeta_n ln(n_t/n)}\right]} \quad \text{where } \zeta_n < 0$$

$\rightarrow$ Setting $\zeta_n < 0$ allows for countercyclical inequality and income risk

- Dividend allocation rule following Debortoli and Gali (2024):

$$d_{i,t} = d_t \frac{e_{i,t}^{1+\zeta_d ln(d_t/d)}}{\mathbb{E}\left[e_i^{1+\zeta_d ln(d_t/d)}\right]} \quad \text{where } \zeta_d < 0$$

$\rightarrow$ Dividends distributed in proportion to household's productivity;
$\zeta_d < 0 \rightarrow$ countercyclical income inequality and income risk

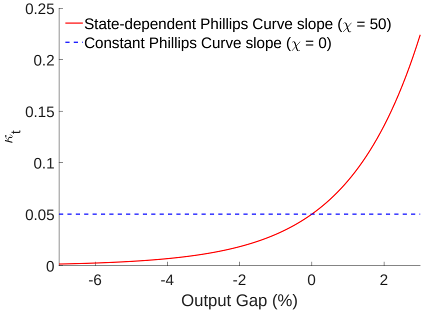
Model: Phillips Curve

- Nonlinear wage Phillips curve following Auclert et al. (2021):

$$\pi_t^w(1+\pi_t^w) = \kappa_t\left(\varphi\, n_t^{\nu} - \frac{1-\tau_t}{\mu_w}\, w_t\, c_t^{-\sigma}\right) n_t + \beta\,\mathbb{E}_t\left[\pi_{t+1}^w\,(1+\pi_{t+1}^w)\right] + \epsilon_t$$

- State-dependent slope as in e.g. Erceg, Jakab and Linde (2021):

$$\kappa_t \;=\; \kappa\, e^{\chi\,(y_t - y)}, \quad \chi \geq 0: \text{ curvature parameter}$$



Model

- Firms: Standard flexible price and monopolistic competition setup
  - Production linear in labor; profits redistributed to households
- Monetary policy:
$$\frac{1+i_t}{1+i} = \left(\frac{1+\pi_t}{1+\pi}\right)^{\phi_\pi} \left(\frac{y_t}{\tilde{y}_t}\right)^{\phi_y} e^{\gamma_t}$$
- Government budget constraint (τ_t adjusts to balance budget):
$$\tau_t y_t + b_t = (1+r_t) b_{t-1} + g$$
- Shocks:
$$\begin{aligned} \text{Demand:} \quad & \gamma_t = \rho_\gamma \gamma_{t-1} + \epsilon_t^\gamma,\ \epsilon_t^\gamma \sim \mathcal{N}(0, \sigma_\gamma^2) \\ \text{Cost-push:} \quad & \varepsilon_t = \rho_\epsilon \varepsilon_{t-1} + \epsilon_t^\varepsilon,\ \epsilon_t^\varepsilon \sim \mathcal{N}(0, \sigma_\varepsilon^2) \end{aligned}$$
- Solve nonlinear model using nonlinear SSJ (Auclert et al., 2021)

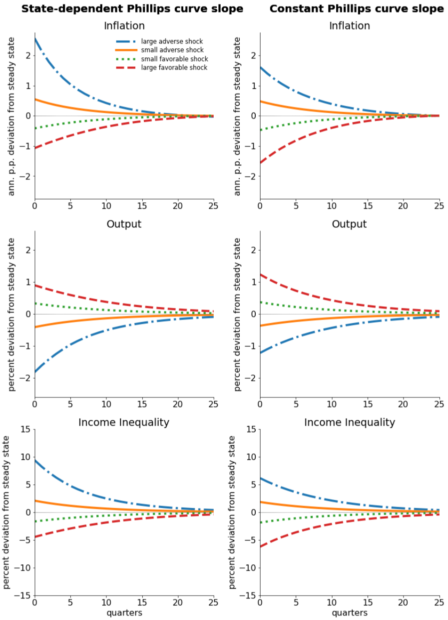
Model Details

Model Calibration

- Match moments of inflation, GDP growth and income inequality (std. log income, detrended) in U.S. data from 1967 to 2019

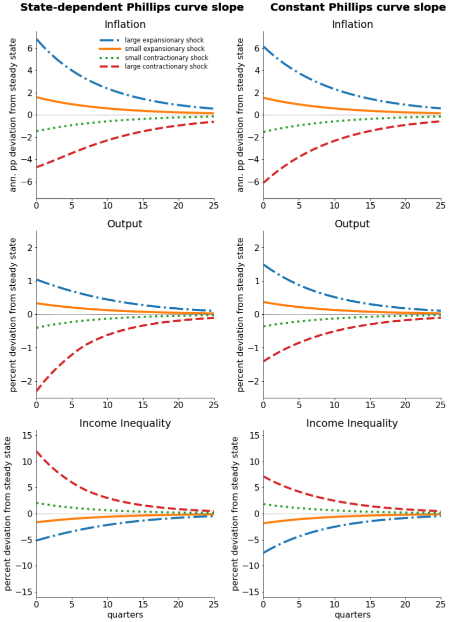
Parameter	Description	Value
β	Quarterly discount factor	0.98
ν	Inverse Frisch elasticity	2
σ	Inverse elasticity of intertemporal substitution	1
φ	Disutility of labor	0.909
μ_w	Steady state gross wage mark-up	1.1
ϕ	Rotemberg wage adjustment cost parameter	208
μ_p	Steady state gross price mark-up	1.2
ϕ_π, ϕ_y	Taylor rule parameters	1.5, 0.2
ζ_n, ζ_d	Cyclical income risk parameters	-4, -10
χ	Curvature Phillips curve slope	50
n_a, n_e	Number of asset and productivity states	500, 11
ρ_e, σ_e	Implied AR(1) and std.dev. idiosync. productivity	0.98, 0.92
ρ_γ, ρ_ϵ	Autocorrelation demand and supply shocks	0.9, 0.9
$100\sigma_\gamma$	Standard deviation demand shock	0.0470
$100\sigma_\epsilon$	Standard deviation cost-push shock	0.0784

Impulse Responses: Cost-Push Shock



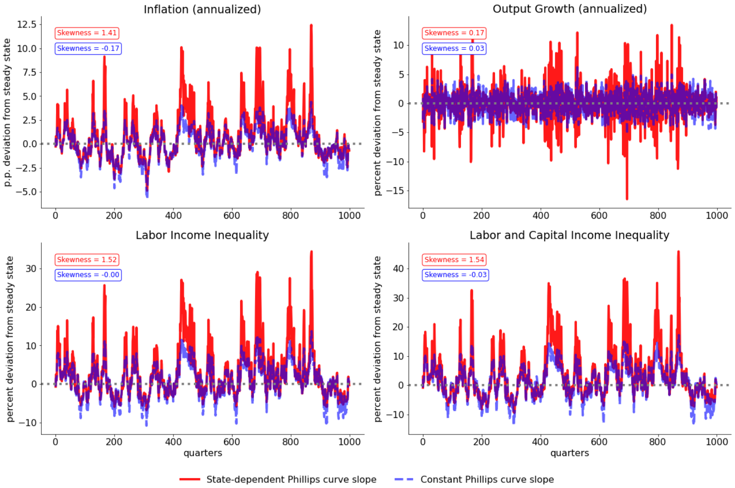
- State-dependent Phillips curve slope amplifies inflation increase and dampens fall in inflation
- Countercyclical inequality: output falls and income inequality increases
- Increase in income inequality is amplified and decrease in income inequality is dampened

Impulse Responses: Demand Shock



- Symmetric shocks produce skewed impulse responses
- Amplified inflation increase, amplified fall in output and amplified increase in inequality

Long Simulation



- Inflation and inequality increase more strongly than they decrease

Model vs. Data Comparison

	Model		Data		
	Phillips curve slope				
	State-dependent	*Constant*	Mean	95% CI	
Standard deviation π_t	2.31	1.51	2.29	2.00	2.55
Skewness π_t	**1.41**	-0.17	1.23	0.93	1.53
Autocorrelation π_t	0.89	0.92	0.92	0.89	0.94
Standard deviation $\triangle y_t$	3.09	1.89	3.14	2.71	3.58
Skewness $\triangle y_t$	0.17	0.03	-0.26	-0.93	0.49
Autocorrelation $\triangle y_t$	-0.02	-0.01	0.30	0.15	0.45
Correlation π_t, $\triangle y_t$	-0.23	-0.19	-0.06	-0.25	0.14

- Model matches positive skewness of inflation
- Constant Phillips curve slope model fails to account for skewness

Model vs. Data Comparison: Inequality

	Model		Data		
	Phillips curve slope				
	State-dependent	*Constant*	Mean	95% CI	
	Labor Income Inequality				
Mean	0.92	0.92	0.92	0.88	0.95
Skewness	**1.52**	0.00	0.85	0.32	1.34
Standard Deviation	0.06	0.04	0.07	0.05	0.08
	Labor and Capital Income Inequality				
Mean	0.94	0.94	1.07	0.99	1.15
Skewness	**1.54**	-0.03	1.15	0.40	1.77
Standard Deviation	0.08	0.06	0.18	0.13	0.23

- Model produces positive skewness of income inequality
- Constant Phillips curve slope model fails to account for skewness

Conclusion

- We introduce a Phillips curve with a state-dependent slope into an otherwise standard nonlinear HANK model
- Our model accounts *jointly* for the positive skewness of inflation and inequality observed in the data
- Over the business cycle, inflation and income inequality increase more strongly than they decrease
- A model version with constant Phillips Curve slope cannot account for these features in the data

Thank you for your attention.

Paper, slides, and codes available at authors' websites.

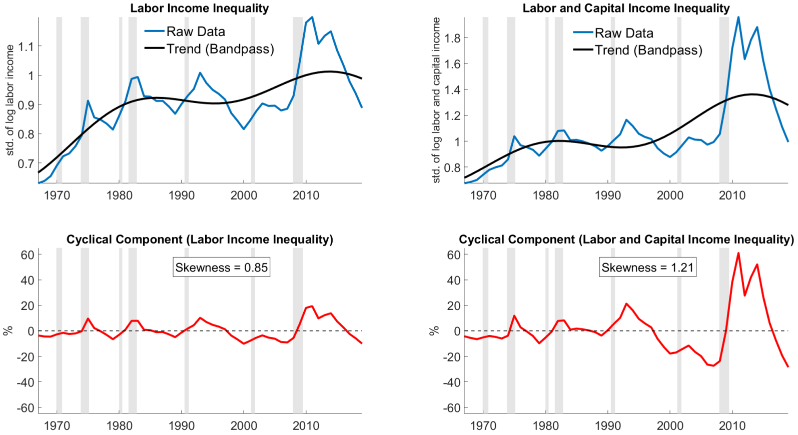
Appendix

Model Details

- Firms:
  - Linear production function:
$$y_t = n_t$$
  - Optimal price setting (μ_p gross price markup):
$$W_t/P_t = w_t = \frac{1}{\mu_p}$$
  - Real profits:
$$d_t = y_t - w_t y_t = \left(1 - \frac{1}{\mu_p}\right) y_t$$
- Market clearing:
  - Goods market:
$$y_t = c_t + g$$
  - Asset market:
$$b_t = \int_0^1 a_{i,t} di$$

Back

Labor and Capital Income Inequality



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The nonlinear Phillips Curve (Phillips, 1958, Economica)

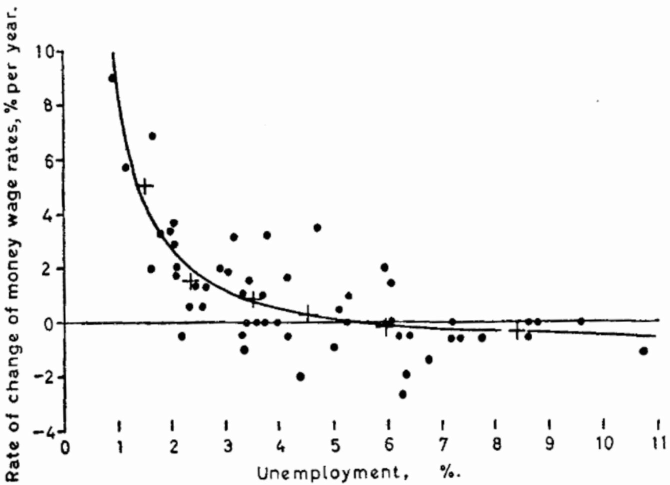
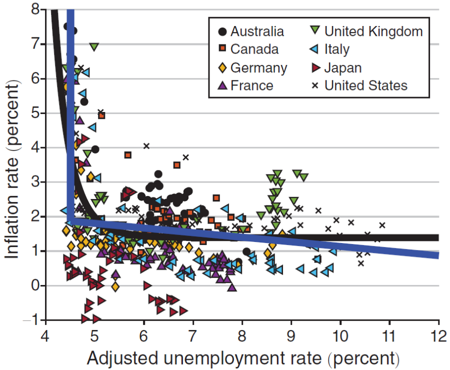


Fig.1. 1861 – 1913

The nonlinear Phillips Curve (Beningo, Eggertsson, 2024, AEA P&P)



Using Okun's Law:
$(y_t - y) = -c * (u_t - u)$

Plug into our κ_t:
$\kappa_t = \kappa e^{-\chi c (u_t - u)}$

$\rightarrow$ If u_t falls, Phillips curve slope steepens

Blue line: $\pi_{i,t} = 2.4722 - 0.1336 \; x \; u^{dev}_{i-t} + \epsilon_t$
for i countries

Black line: $\pi_{i,t} = a + b \left(\frac{1}{u^{dev}_{i,t}} \right)^c$