Inside Money, Employment, and the Nominal Rate

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Motivation

How to study the nominal macroeconomy?

- New Keynesianism
- (New) Monetarism
  - Only good for the long term? (upward sloping Phillips curve)
  - Applicability in “cashless” economies?

Overview

- Cash-in-Advance
  - $+$ More labor $\rightarrow$ **Result 1:** downward sloping Phillips curve
  - $+$ Inside money $\rightarrow$ **Result 2:** financial sector integration

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  → **Result 3:** "Monetarist IS-LM"

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The representative household:

- Consumes
- Supplies labor
- Operates firms
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  - Choose $\frac{A_{SS}^B}{A_{SS}^F}$ s.t. $\frac{L_{SS}^B}{L_{SS}} \approx \frac{\text{Fin. sector employment}}{\text{Total employment}}$

Model overview

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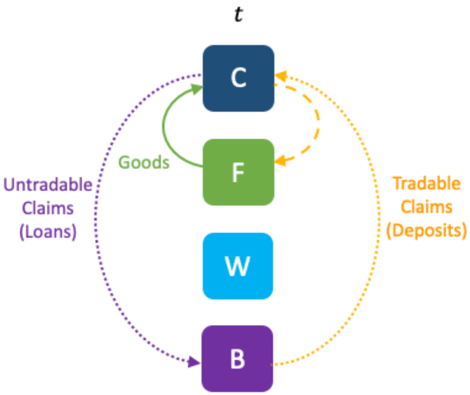

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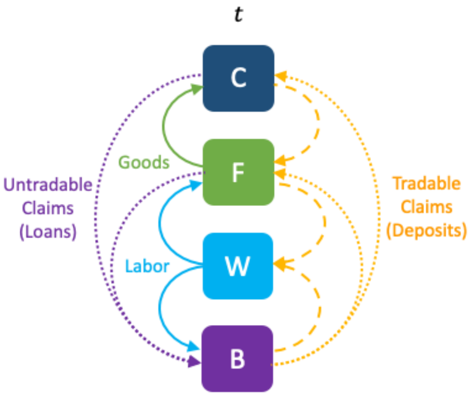

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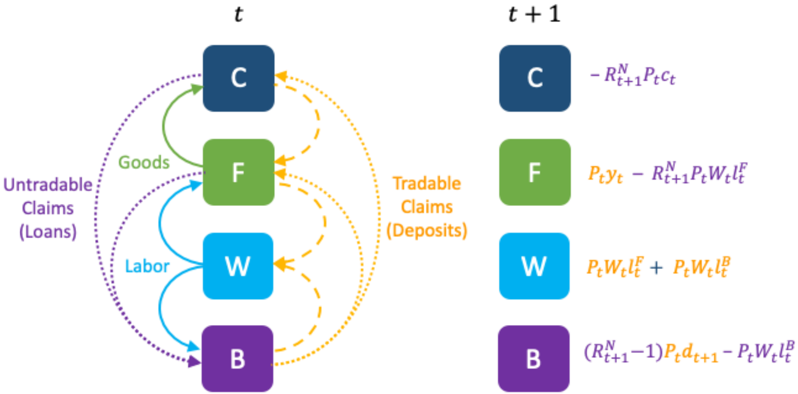

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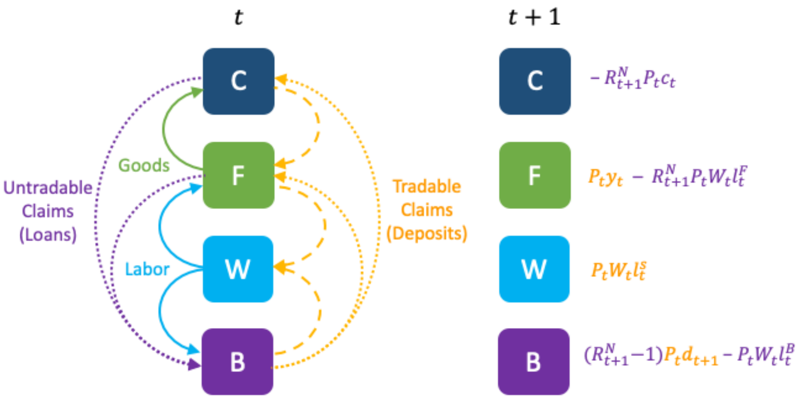

Household problem + +

$$\max_{\ell_t^S,\ell_t^F,\ell_t^B,b_{t+1}} \mathbb{E}_t \sum_{\tau=t}^{\infty} \beta^{t+\tau} \frac{x_{t+\tau}^{1-\gamma}}{1-\gamma}$$

$$\text{s.t. } P_{t\text{-}1} W_{t\text{-}1} \ell_{t\text{-}1}^S + P_{t\text{-}1} \underbrace{A_{t\text{-}1}^F \ell_{t\text{-}1}^F}_{y_{t\text{-}1}} + (R_t^N - 1) P_{t\text{-}1} \underbrace{A_{t\text{-}1}^B \ell_{t\text{-}1}^B}_{d_t - CB_t} + R_t^N P_{t\text{-}1} b_t =$$

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→ When also no intermediation cost ($R_t^B = R_t^D$), $L_t^\eta = W_t = A_t^F$ (Friedman Rule)

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- Multiple possible channels
  - **Liquidity constraints:** e.g. Piazzesi & Schnieder (2021), Bianchi & Bigio (2022)
  - **Capital constraints:** e.g. Gertler & Karadi (2011), He & Krishnamurthy (2013)
  - **Competition:** e.g Drechsler, Savov, & Schnabl (2017), Lagos & Zhang (2020)

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  - Monetary policy rule (determines quantity of CB_{t+1}): $R_{t+1}^N = R_{ss}^N (\frac{\pi_t}{\pi_{ss}})^{\phi^\pi} (\frac{L_t}{L_{ss}})^{\phi^L} v_t$

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$$\frac{1}{R^N_{t+1}} = \beta \frac{\mathbb{E}[x_{t+1}^{-\gamma}]}{x_t^{-\gamma}} \frac{1}{\pi_{t+1}} \qquad \text{(Euler equation)}$$

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$$W_t = \beta \frac{\mathbb{E}[x_{t+1}^{-\gamma}]}{x_t^{-\gamma}} \frac{1}{\pi_{t+1}} A_t^F \qquad \text{(Firm labor demand)}$$

$$W_t + \frac{\lambda_t^{RR} A_t^B}{x_t^{-\gamma}} = \beta \frac{\mathbb{E}[x_{t+1}^{-\gamma}]}{x_t^{-\gamma}} \frac{1}{\pi_{t+1}} (R^N_{t+1} - 1) A_t^B \qquad \text{(Bank labor demand)}$$

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$$B_{t+1} + B_{t+1}^B + B_{t+1}^{CB} = 0 \qquad \text{(Bond market clearing)}$$

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Solution:

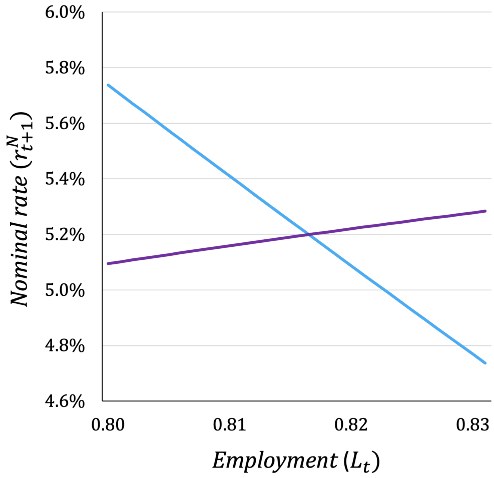
$$L_t^{\eta} = (\frac{1}{R_{t+1}^N})^2 A_t^F \qquad \text{(Goods supply / Money demand)}$$

$$L_t^{\eta} = \frac{1}{R_{t+1}^N}(\frac{1}{R_{t+1}^N}(R_{t+1}^N - 1) - \frac{\lambda_t^{RR}}{X_t^{-\gamma}})A_t^B \qquad \text{(Money supply)}$$

$$\frac{1}{R_{t+1}^N} = \beta \frac{\mathbb{E}[X_{t+1}^{-\gamma}]}{X_t^{-\gamma}} \frac{1}{\pi_{t+1}} \qquad \text{(Euler equation)}$$

$$R_{t+1}^N = R_{ss}^N (\frac{\pi_t}{\pi_{ss}})^{\phi^{\pi}} (\frac{L_t}{L_{ss}})^{\phi^L} v_t \qquad \text{(Monetary policy rule)}$$

Result 3: "Monetarist IS-LM"



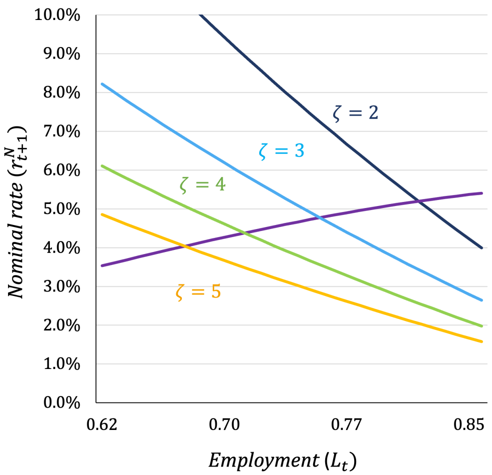
Goods supply equation ("IS curve")

$$1 + r^N_{t+1} = \left(\frac{A^F_t}{L^\eta_t}\right)^{\frac{1}{2}}$$

Money supply equation ("LM curve")

$$1 + r^N_{t+1} = \left(\frac{1 - \lambda^{RR}_t / X_t^{-\gamma} - \sqrt{(1 - \lambda^{RR}_t / X_t^{-\gamma})^2 - 4\, L^\eta_t / A^B_t}}{2\, L^\eta_t / A^B_t}\right)$$

Note: strength of monetarist channel depends on supply chain depth



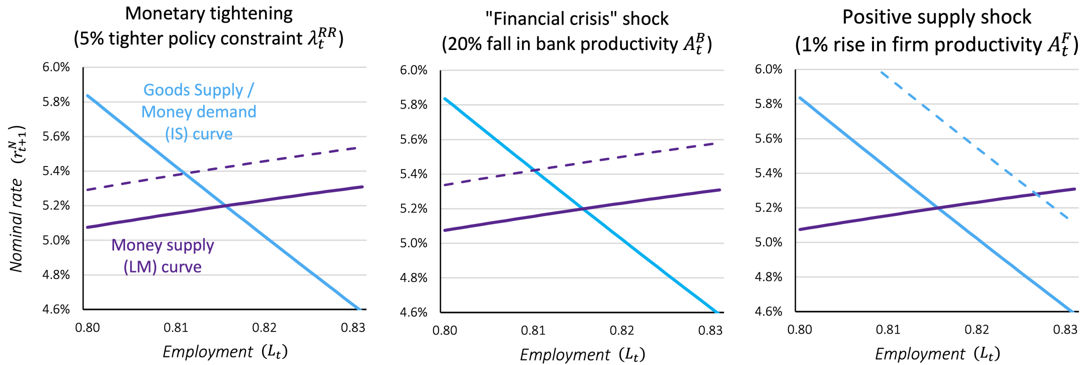
Goods supply equation ("IS curve")

$$1 + r^N_{t+1} = \left(\frac{A_t^F}{L_t^\eta}\right)^{\frac{1}{\zeta}}$$

Money supply equation ("LM curve")

$$1 + r^N_{t+1} = \left(\frac{1 - \lambda_t^{RR}/X_t^{-\gamma} - \sqrt{(1 - \lambda_t^{RR}/X_t^{-\gamma})^2 - 4\,L_t^\eta/A_t^B}}{2\,L_t^\eta/A_t^B}\right)$$

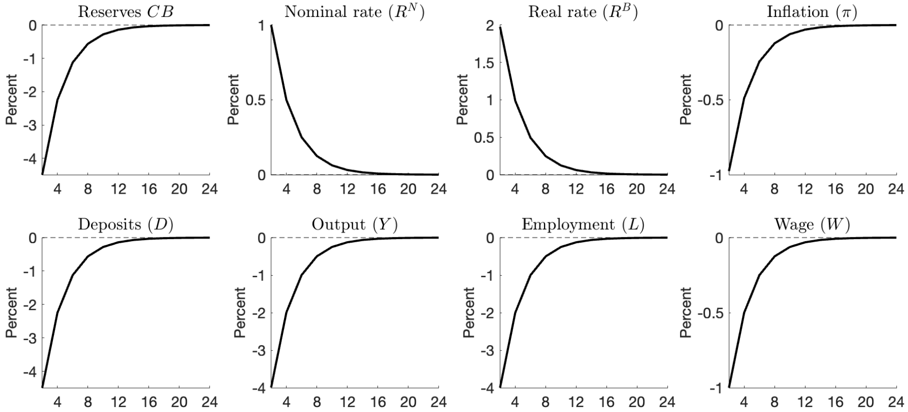
Result 2: financial sector integration



IS: $(1 + r_{t+1}^N) = \left(\frac{A_t^F}{L_t^\eta}\right)^{\frac{1}{2}}$

LM: $(1 + r_{t+1}^N) = \left(\frac{(1-\lambda_t^{RR}/X_t^{-\gamma}) - \sqrt{(1-\lambda_t^{RR}/X_t^{-\gamma})^2 - 4\,L_t^\eta/A_t^B}}{2\,L_t^\eta/A_t^B}\right)$

Result 1: downward sloping Phillips curve



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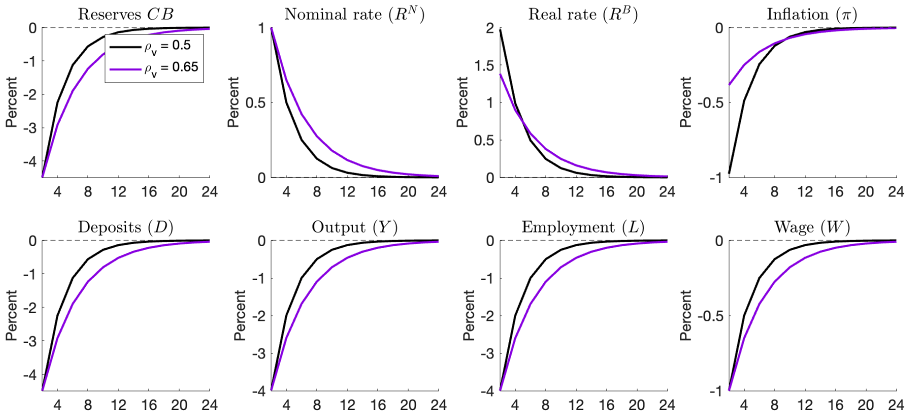

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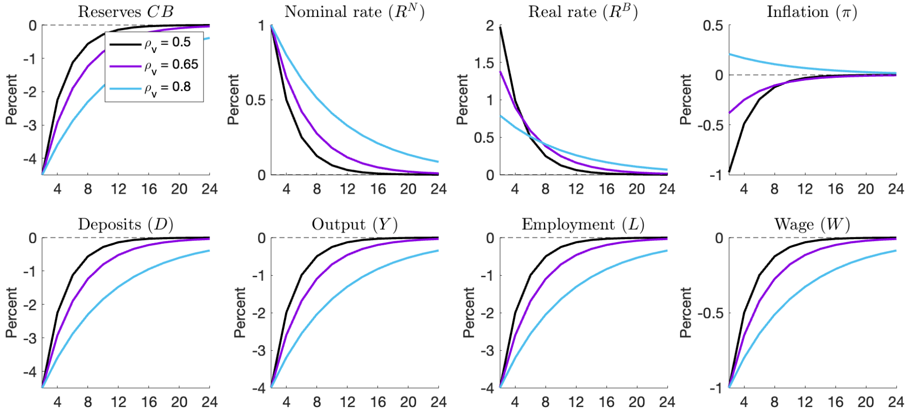
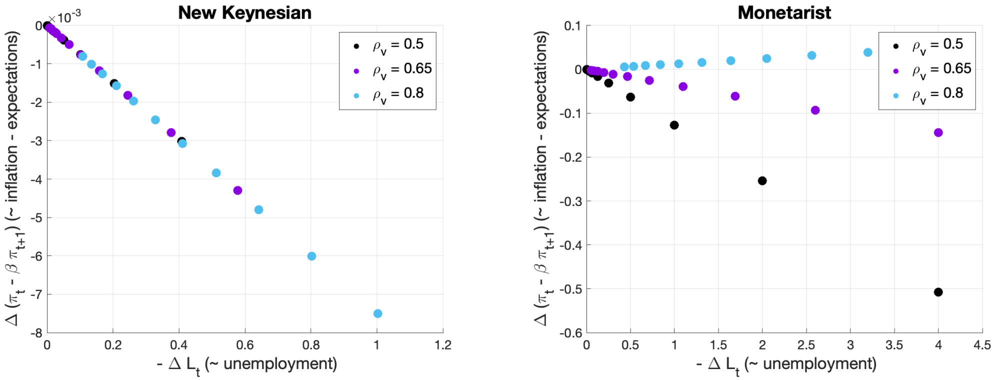


Result 1: downward sloping Phillips curve

- Response to identical monetary policy shocks in sticky price vs flexible price model:



Calibration

Name	Parameter	Value	Target	Notes
Preferences				
Time preference	β	.961	R^B_{ss}	Di Tella et al, 2023
Frisch Elasticity	η	2	$\sim L_t$ dynamics	Standard: $\approx$ .5
CRRA	γ	5	$\sim \pi_{t+1}$ dynamics	Standard: at least 2
Technology				
Relative fin. productivity	A^B_{SS}/A^F_{SS}	100	L^F_t/L_t	NIPA: $\approx$ 5%
Nominal frictions	θ	0 / 0.9	PC slope	Hazell et al (2022)
Policy				
Steady state nominal rate	R^N_{ss}	1.052	π_{ss}	NIPA: $\approx$ 2.3%
Response to inflation	ϕ^π	0 / 1.01		Depends on experiment
Response to employment	ϕ^L	0 / 0		Depends on experiment
Reserve requirement	ϕ^{RR}	0.25	D_t/CB_t	M2/M0 $\approx$ 5

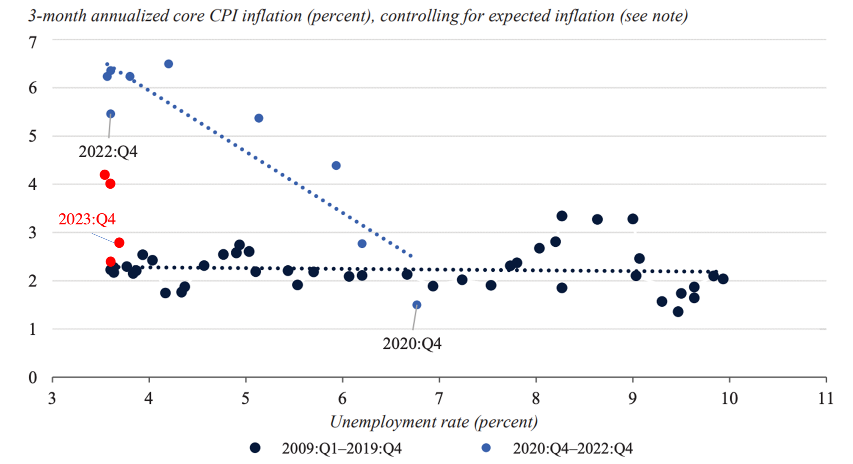
Aggregate demand?

- New Keynesian: all "demand" shocks work the same way
- Monetarist IS-LM:
  - Productivity shocks: shift IS curve
  - Financial & Monetary shocks: shift LM curve
  - Risk shocks: $\sim$ shift IS curve

Thanks!

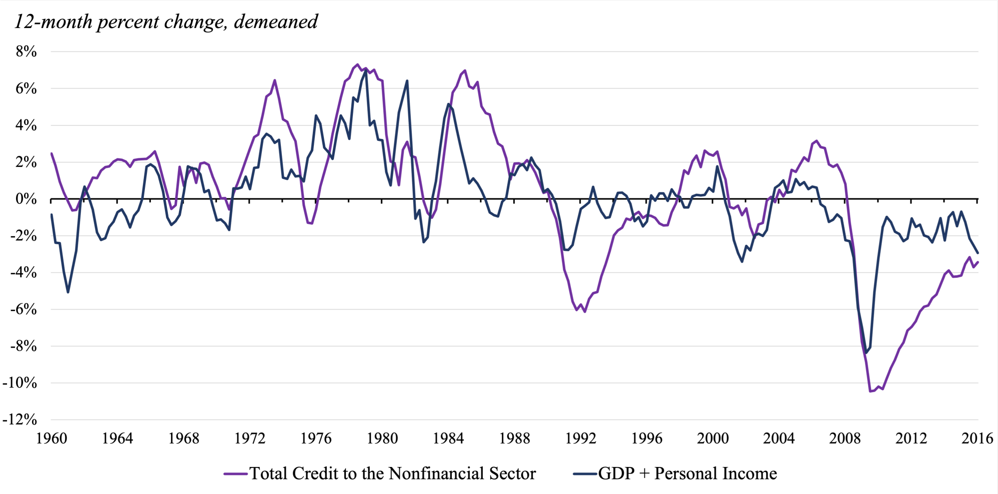
Appendix

Comparing predictions: the expectations-augumented Phillips curve back



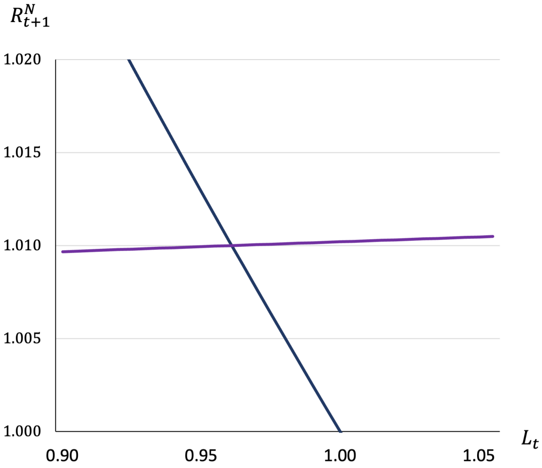
Sources: Bureau of Labor Statistics; Federal Reserve Bank of Philidelphia.
Note: CPI = Consumer Price Index. The y axis shows a measure of the actual rate of inflation minus the difference betwen the expected rate of inflation and the long-term rate of inflation, or π - (E[π] - π*), where π = core CPI inflation, E[π] = 1-year lagged median 1-year ahead core CPI inflation expectations from the Federal Reserve Bank of Philidelphia's Survey of Professional Forecasters, and π* = the long-term (post-2000) average of core CPI inflation, 2.3 percent. Actual CPI inflation seasonally adjusted.

Real transactions and gross private debt are correlated



- Related: Fisher (1933), Levine (1997), Schularick & Taylor (2012), etc

"Free banking" case



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Adding sticky prices Household problem back

Flexible price, perfect competition solution

$$L_t^{\eta} = (\frac{1}{R_{t+1}^N})^2 A_t^F \qquad \text{(Goods supply)}$$

$$L_t^{\eta} = \frac{1}{R_{t+1}^N}(\frac{1}{R_{t+1}^N}(R_{t+1}^N - 1) - \frac{\lambda_t^{RR}}{X_t^{-\gamma}})A_t^B \qquad \text{(Money supply)}$$

$$\frac{1}{R_{t+1}^N} = \beta \frac{\mathbb{E}[X_{t+1}^{-\gamma}]}{X_t^{-\gamma}} \frac{1}{\pi_{t+1}} \qquad \text{(Euler equation)}$$

$$R_{t+1}^N = R_{ss}^N (\frac{\pi_t}{\pi_{ss}})^{\phi^{\pi}} (\frac{L_t}{L_{ss}})^{\phi^L} v_t \qquad \text{(Monetary policy rule)}$$

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Adding sticky prices Household problem back

Flexible price, perfect competition solution

Sticky price, imperfect competition solution

$$\hat{a}^F_t - \eta \hat{l}^*_t - 2\hat{r}^N_{t+1} = 0 \qquad \text{(Flexible price goods supply equation)}$$

$$\hat{a}^B_t - \eta \hat{l}_t + \left(\frac{A^B_{ss}}{L^\eta_{ss}} - 1\right)\hat{r}^N_{t+1} - \left(\frac{A^B_{ss}\lambda^{RR}_{ss}}{L^\eta_{ss} R^N_{ss} X^{-\gamma}_{ss}}\right)\hat{\lambda}^N_t = 0 \qquad \text{(Money supply equation)}$$

$$\hat{x}_t = \frac{-1}{\gamma}(\hat{r}^N_{t+1} - \hat{\pi}_{t+1}) + \mathbb{E}[\hat{x}_{t+1}] \qquad \text{(Euler equation)}$$

$$\hat{r}^N_{t+1} = \phi^\pi \hat{\pi}_t + \phi^L \hat{l}_t + v_t \qquad \text{(Monetary policy rule)}$$

$$\hat{\pi}_t = \frac{(1-\beta\theta)(1-\theta)}{\theta}\eta(\hat{y}_t - \hat{y}^*_t) + \beta\mathbb{E}[\hat{\pi}_{t+1}] \qquad \text{(New Keynesian Phillips curve)}$$

Adding sticky prices

- The New Keynesian output gap is proportional to the difference between the policy-determined nominal rate R^N and the "natural" real rate R^*
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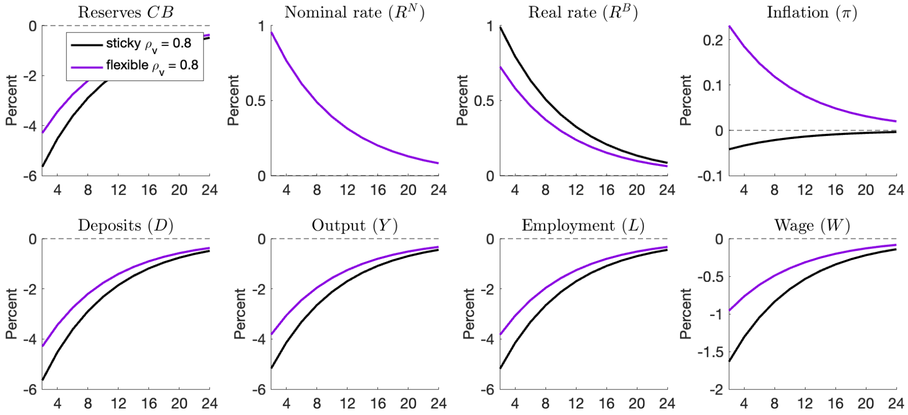
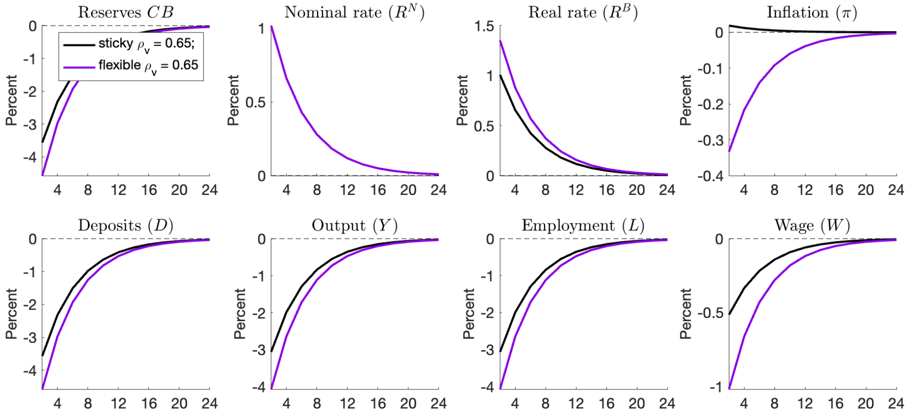
- Two cases:
  1. More persistent shock: $\Delta R^* < \Delta R^N \rightarrow$ flexible price Fisherian inflation, sticky price **contraction**; monetarist & New Keynesian mechanisms are complementary
  2. Less persistent shock: $\Delta R^* > \Delta R^N \rightarrow$ flexible price disinflation, sticky price **expansion**; monetarist & New Keynesian mechanisms work in opposite directions

Case 1: More persistent shock



Case 2: Less persistent shock back



Entrepreneurial risk back

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- But, most macro models feature a spot, riskless labor market. To make labor risky, need to assume that labor is chosen in advance, aka add "entrepreneurial risk"

Entrepreneurial risk: simple example

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Household problem:

$$\max_{\{\ell_t^S, \ell_t^F\}} \quad \mathbb{E}_{t=0} \sum_{\tau=t}^{\infty} \beta^{t+\tau} \frac{x_{t+\tau}^{1-\gamma}}{1-\gamma}; \quad x_t \equiv c_t - \frac{{\ell_t^S}^{1+\eta}}{1+\eta}$$

$$\text{s.t. } W_t \ell_t^S + A_t \ell_t^F = c_t + W_t \ell_t^F$$

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Labor supply: ${\ell^S_{t+1}}^{\eta} = W_{t+1}$

Labor demand: $\mathbb{E}[x_{t+1}^{-\gamma}]W_{t+1} = \mathbb{E}[x_{t+1}^{-\gamma} A_{t+1}]$

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$$\rightarrow \; L^{\eta}_{t+1} = \frac{\mathbb{E}[X_{t+1}^{-\gamma}A_{t+1}]}{\mathbb{E}[X_{t+1}^{-\gamma}]}$$

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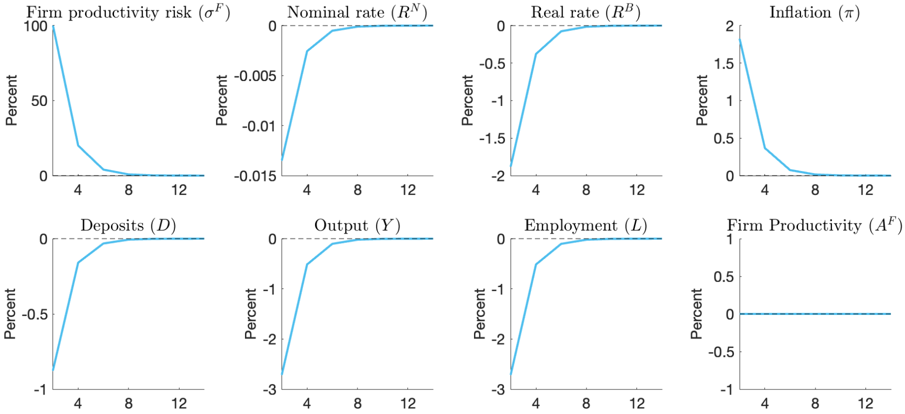
Technology: $\ln A^F_t = \rho_F \ln A^F_{t\text{-}1} + \sigma^F_{t\text{-}1}\epsilon^F_t; \;\; \ln \sigma^F_t = \rho_{\sigma^F} \ln \sigma^F_{t\text{-}1} + \sigma_{\sigma^F}\epsilon^{\sigma^F}_t$

Entrepreneurial risk + inside money +

- Solution via third order perturbation, following Basu & Bundick (2017)



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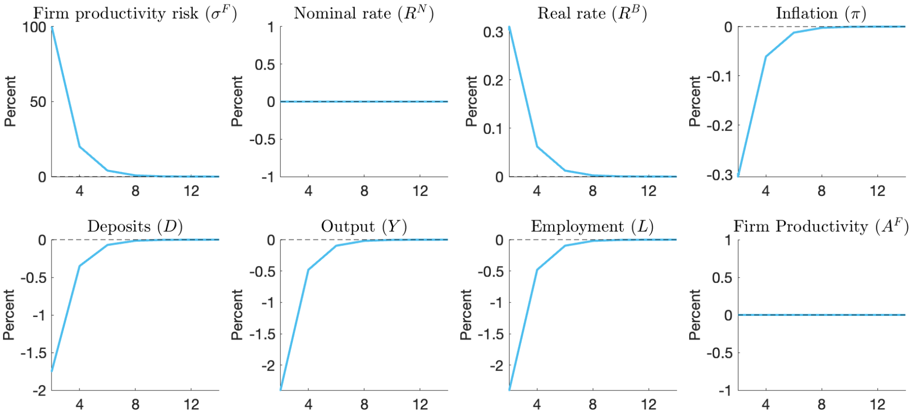

Entrepreneurial risk: applications

back

- Demand shocks
  - "Uncertainty" increasingly popular as an explanation for business cycles
  - With a reasonable policy rule, can get a **deflationary** contractionary shock
- Financial development
  - With idiosyncratic risk, increases in financial sector productivity or means cheaper insurance, lower risk, and real economic expansion
- Fiscal policy
  - With idiosyncratic risk, redistributive fiscal policy likewise expansionary
  - If the fiscal authority takes on the entrepreneurial risk, Ricardian equivalence also does not hold