Endogenous Firm Entry and the Supply-Side Effects of Monetary Policy

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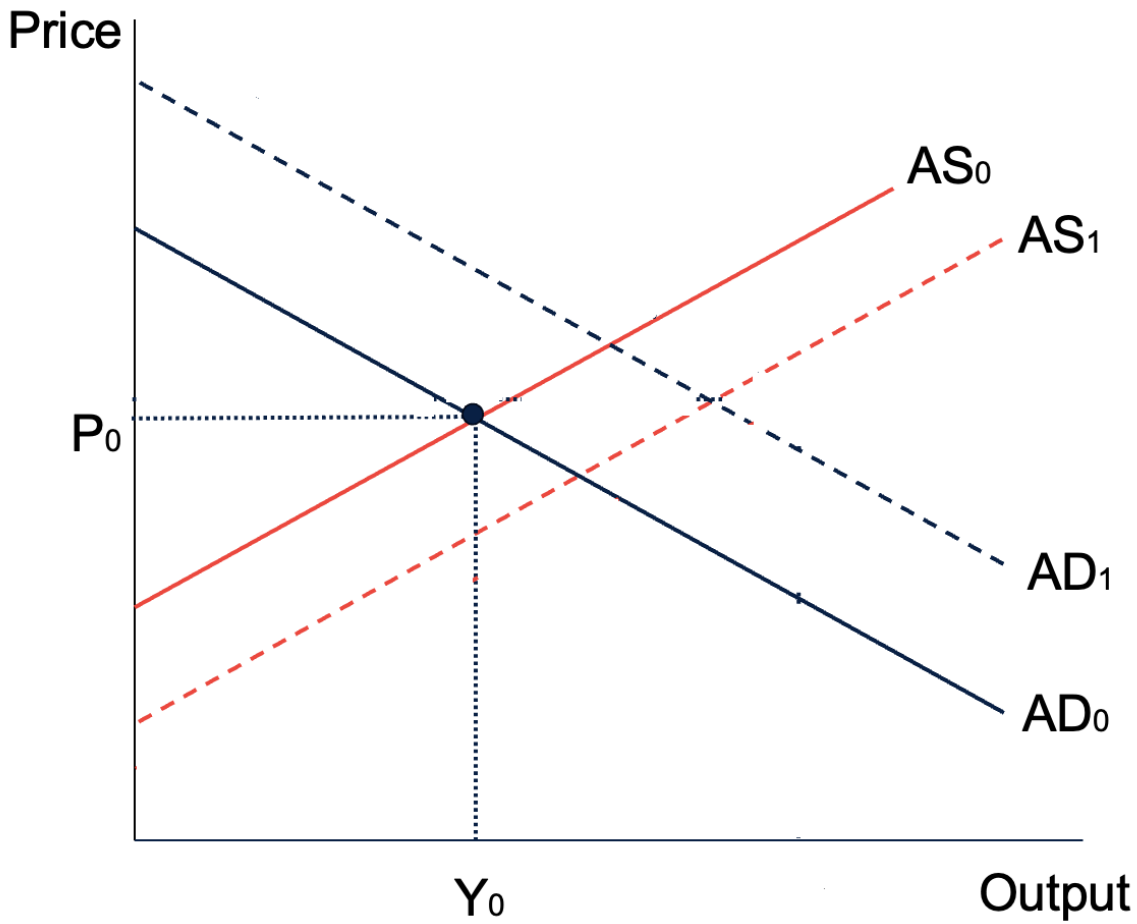
Motivation

- Supply and demand shocks come together during the COVID-19 crisis
- Understanding the interaction is important for policy design

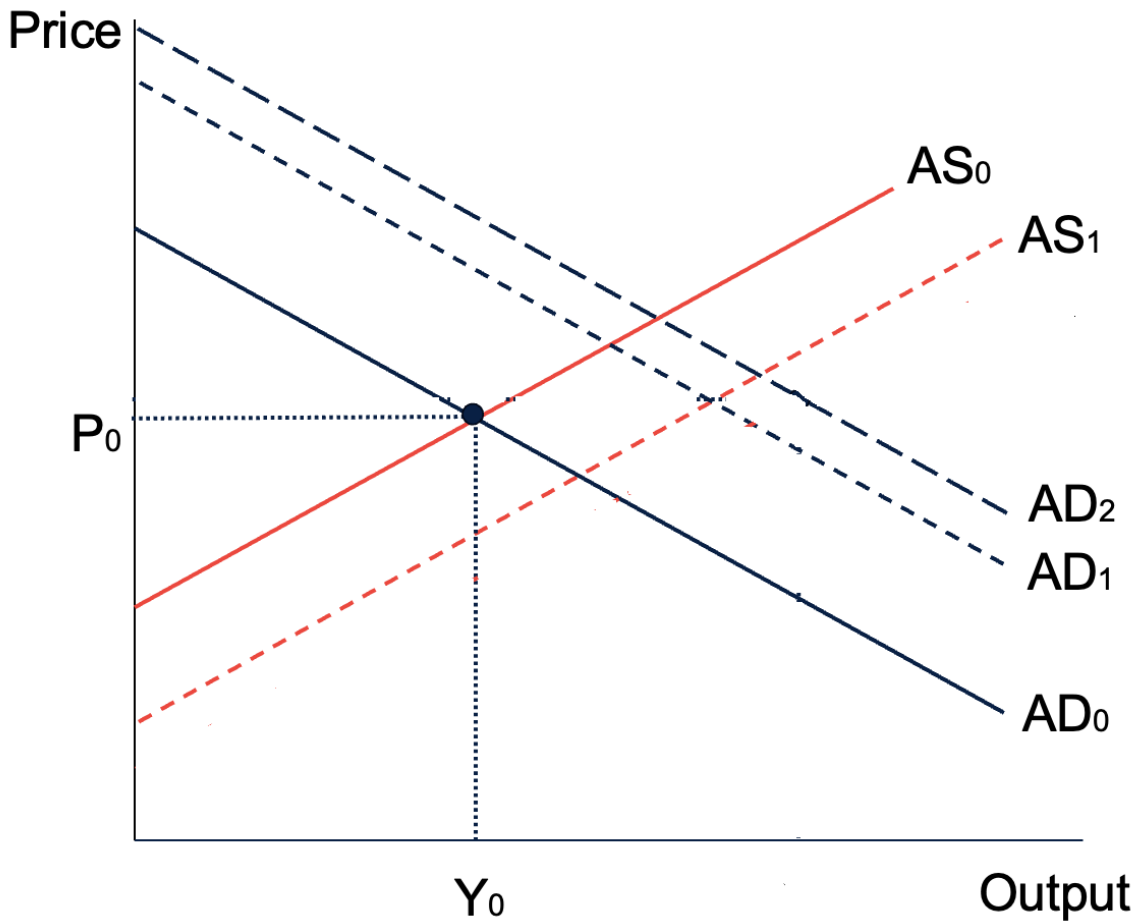
AD-AS comovements

- Exogenous demand shocks encourage firm entry



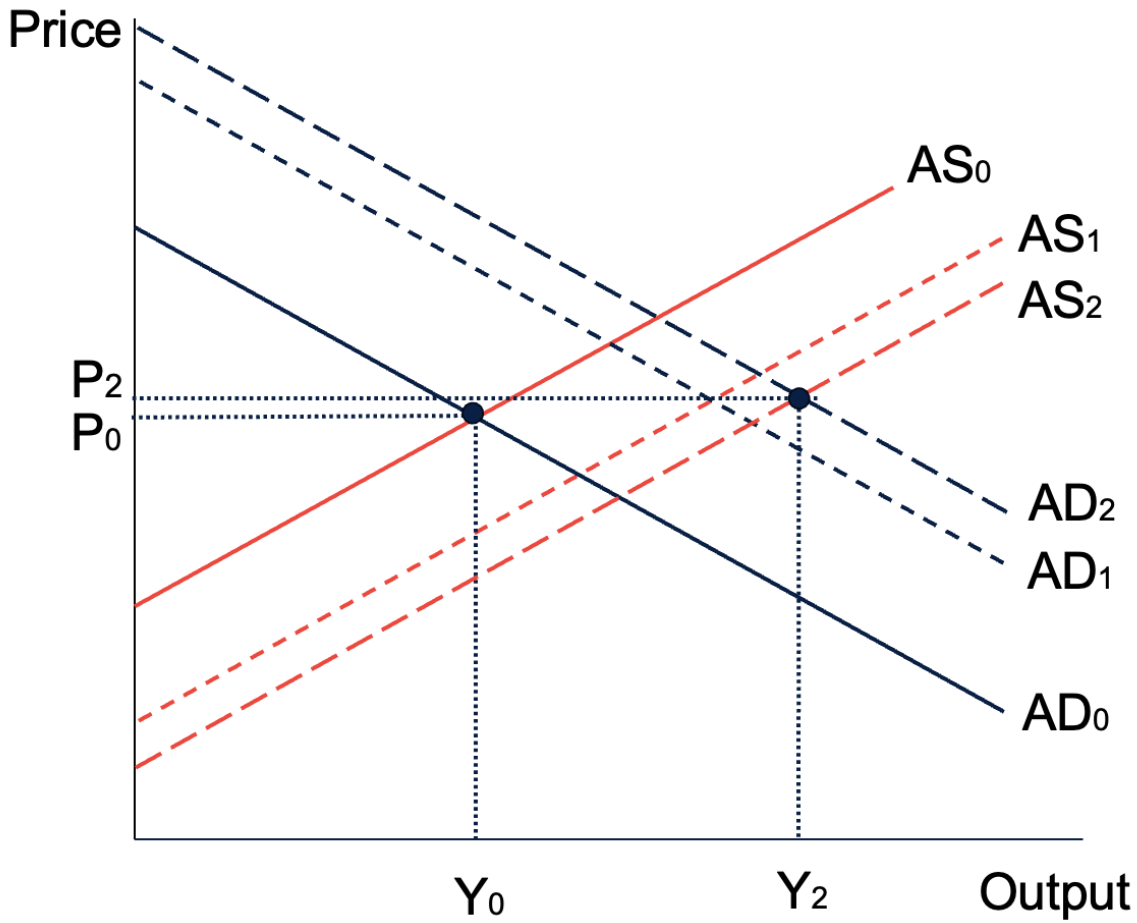
AD-AS comovements

- New firms buy equipment and build factories, boosting demand



AD-AS comovements

- Demand (from entrants) further encourages entry and boosts supply



This paper

1. A model with endogenous firms entry that incorporates
   - Simultaneous co-movement of supply and demand (feedback loop)
   - Monetary policy's supply-side effects

     Mechanism: monetary tightening $\Rightarrow$ lower AD & higher loan rates $\Rightarrow$ less firm entry $\Rightarrow$ lower AD (potential entrants) $\Rightarrow$ decrease AS, $\cdots$
   - A sufficient statistic: Policy room $\equiv \frac{\text{Policy rate}}{\text{Satiation bound}}$

     Satiation bound: threshold policy rate that ensures full market participation of firms

2. Empirical support:
   - 2% wider policy room $\Rightarrow$ additional 3% response in output to the monetary shock (25 bp)

Theory

Implications

Empirical Analysis

The model: overview

A standard New Keynesian model with:

1. Firm entry decision depends on:
   productivity, fixed cost, interest rate, ...

2. Fixed cost for entry: in final goods
   New entrants generate demand

- interest rate $\Rightarrow$ consumption-saving $\Rightarrow$ demand
- **interest rate $\Rightarrow$ entry $\Rightarrow$ supply**

The model: households

The representative household's problem:

$$\max_{\{C_{t+j},N_{t+j}\}} E_t \sum_{j=0}^{\infty} \beta^j \left[\phi_{c,t} \cdot \log\left(C_{t+j}\right) - \left(\frac{\eta}{\eta+1} \right) \cdot N_{t+j}^{\left(\frac{\eta+1}{\eta}\right)} \right],$$

subject to

$$C_t + \frac{D_t}{P_t} + \frac{B_t}{P_t} = \frac{R_{t-1}^D D_{t-1}}{P_t} + \frac{R_{t-1}^B B_{t-1}}{P_t} + \frac{W_t N_t}{P_t} + \frac{\Upsilon_t}{P_t},$$

where D_t is deposit, B_t is government bonds, Υ_t is lump-sum transfers.

Monetary policy impact 1: lower deposit rate increase demand

The model: firms

Two layers of firms

- Downstream industry ($u \in [0,1]$)
  - Monopolistic competitive, Calvo sticky price
- Upstream industry ([fixed cost $= m$, productivity $= v$])
  - Monopolistic competitive, entry cost, flexible price

$$\underbrace{\text{Labor } N_{mv,t} + \text{fixed entry cost } F_{m,t-1} \Rightarrow J_{mv,t} \xrightarrow[\text{across } m,\, v]{\text{aggregate}} J_t}_{\text{Upstream firms}}$$

$$\underbrace{\cdots \Rightarrow J_t(u) \xrightarrow{\text{one-to-one}} Y_t(u) \xrightarrow[CES]{\text{aggregate}} Y_t}_{\text{Downstream firms}}$$

The model: upstream firms

The upstream firm's problem:

$$\Pi^J_{mv,t} = \left(1+\zeta^J\right) P^J_{mv,t}\varphi_{mv,t}N^{\alpha}_{mv,t} - W_t N_{mv,t} - R^J_{t-1}P_{t-1}F_{m,t-1},\ 0<\alpha<1,$$

where

1. Productivity $\varphi_{mv,t} \sim \mathcal{P}\left(\frac{\kappa-1}{\kappa}A_t, \kappa\right)$
2. Fixed cost $F_{m,t} \sim \mathcal{P}\left(\frac{\omega-1}{\omega}F_t, \omega\right)$, with $F_t = \phi_f \bar{Y}_t exp(u_{f,t})$ Comparative Analysis
3. Loan rate R^J_{t-1}
4. Enter if $\varphi_{mv,t} > \varphi^*_{m,t}$ [lower $R^J_{t-1} \Rightarrow$ lower $\varphi^*_{m,t}$ — $\underbrace{min(\varphi_{mv,t}) = \varphi^*_{m,t}}_{\text{gives } \mathbf{R^{J,*}_{m,t-1}}}$]

Satiation Bound $\mathbf{R^{J,*}_{m,t}}$: the policy rate when all firms with $F_{m,t}$ are operating

Monetary policy impact 2: lower policy rate increase supply (entry)

The model: other parts

- Taylor Rule:

$$R_t^B = R_t^J = R^J \cdot \left(\frac{\Pi_t}{\Pi}\right)^{\tau_\pi} \left(\frac{Y_t}{\bar{Y}_t}\right)^{\tau_y} \cdot \exp\{\varepsilon_{r,t}\} \quad .$$

- Market clearing:

$$C_t + \underbrace{\mathbf{L_t/P_t}}_{\text{entry boosts demand}} + G_t = Y_t.$$

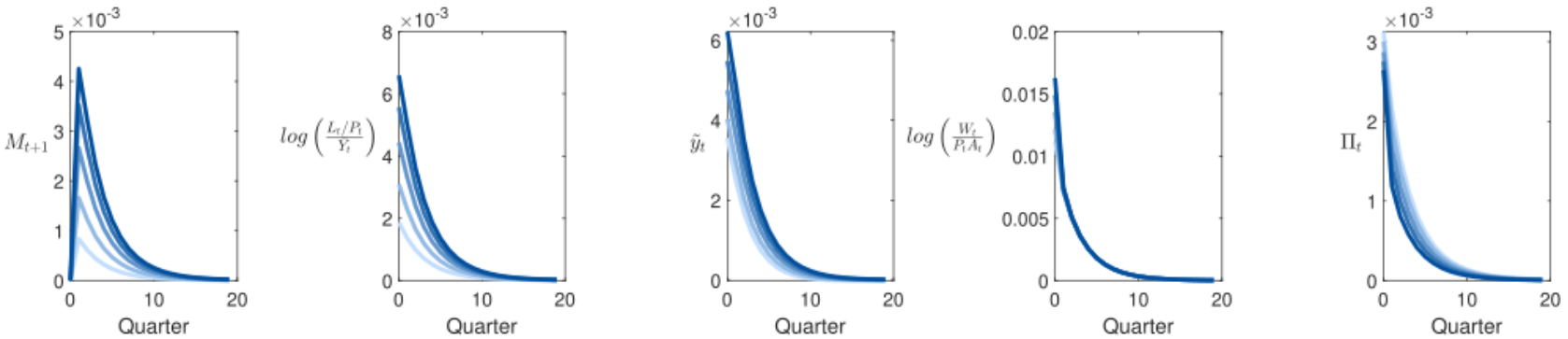
Calibration SS

Theory

Implications

Empirical Analysis

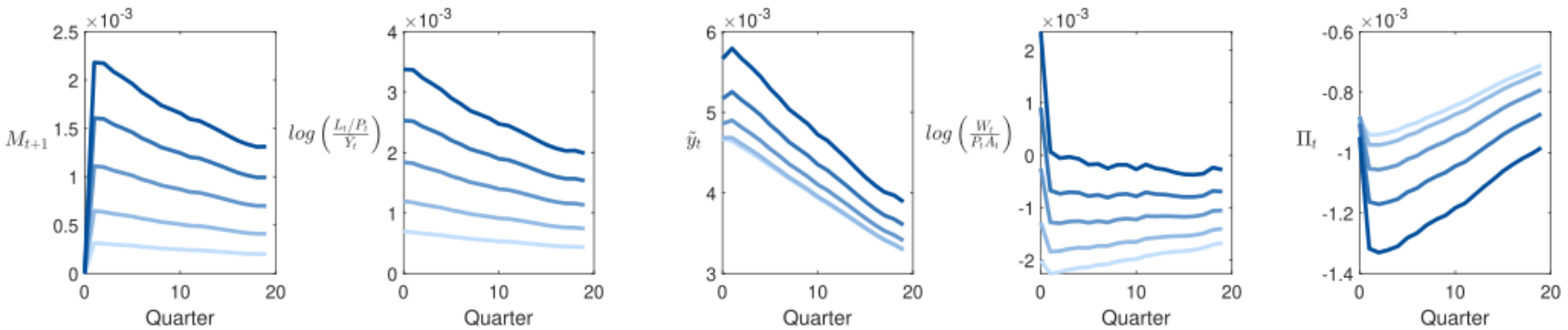
A shock to technology (impulse response to $u_{a,t}$)



- Productivity↑ $\Rightarrow$ entry↑ $\Rightarrow$ loans and aggregate demand↑, labor demand and wage↑ $\Rightarrow$ inflation and interest rate↑, narrowing policy room

- (From light to dark blue, ϕ_f values increasing):
  higher ϕ_f, **less** active firms initially, **stronger** entry-channel effects

A shock to demand preference (impulse response to $u_{c,t}$)

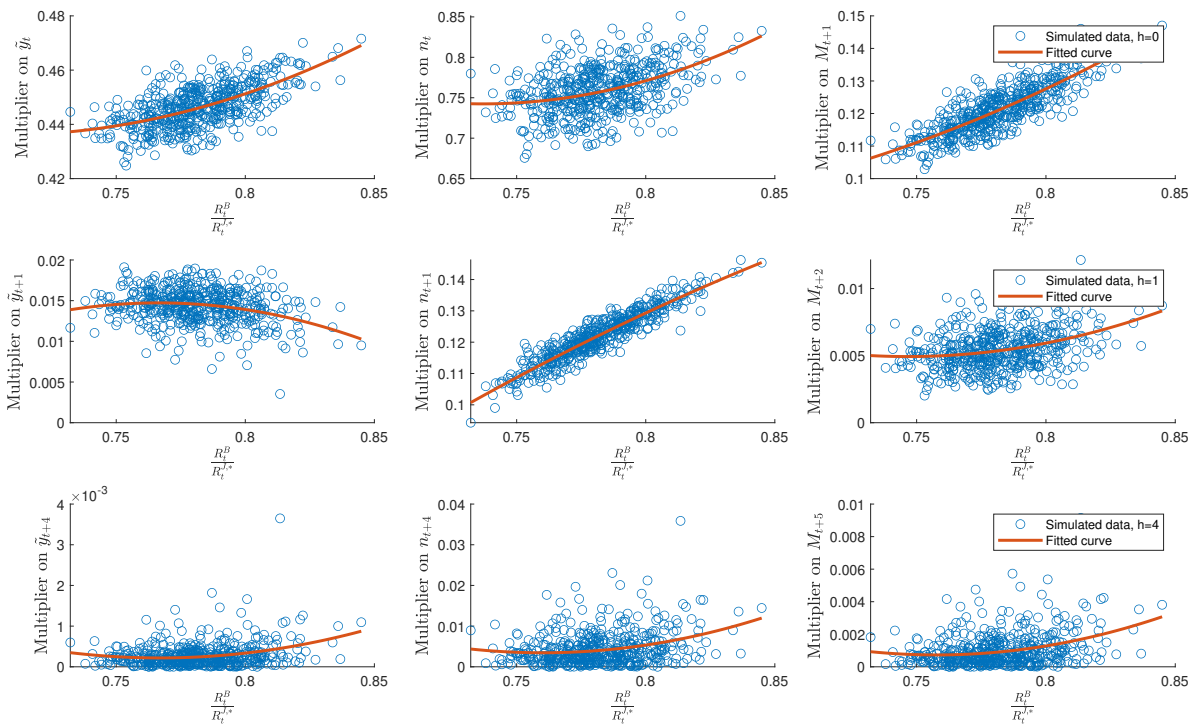


- Preference↑ ⇒ entry↑ ⇒ expansion of aggregate supply capacity
- Qualitatively analogous responses to supply and demand shocks

government spending | monetary policy | fixed cost

Multiplier and policy room: monetary policy shock

1. Simulate the model for 10,000 periods, select 500 realizations: $\mathbb{Y}^{\text{original}}$
2. IRFs to monetary policy shocks starting from each realization drawn from 1, and calculate the multipliers: $\frac{|\mathbb{Y}^{\text{shock}}_{t+h} - \mathbb{Y}^{\text{original}}_{t+h}|}{\sigma(\text{shock})}$.
3. Plot the initial policy room and the multiplier from horizon 0 to 4.



Theory

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Empirical responses to monetary policy shocks with policy room

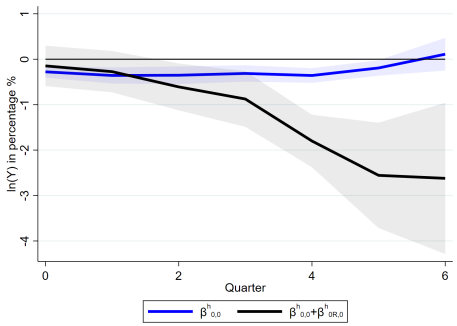
Benchmark Jordà (2005) local projection:

$$\tilde{y}_{t+h} = \sum_{q=1}^{Q} \beta_{\tilde{y},q}^{(h)} \tilde{y}_{t-q} + \sum_{q=1}^{Q} \beta_{R,q}^{(h)} \widehat{r_{t-q}^{B} - r_{t-q}^{J*}} + \sum_{q=0}^{Q} \gamma_{q}^{(h)} \text{controls}_{t-q}$$
$$+ \sum_{q=0}^{Q} \beta_{0,q}^{(h)} \epsilon_{t-q} + \sum_{q=0}^{Q} \beta_{0R,q}^{(h)} \epsilon_{t-q} \times \widehat{r_{t-q-1}^{B} - r_{t-q-1}^{J*}} + u_{t+h}^{(h)} , \quad \text{for } h = 0, \ldots, H,$$

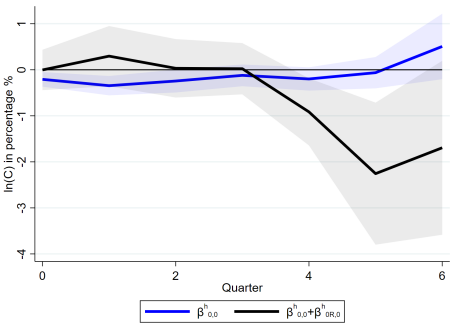
1. Monetary policy shocks, ϵ_t: Acosta (2023)'s extension of Romer and Romer (2004)
2. Policy room, $\widehat{r_{t-q-1}^{B} - r_{t-q-1}^{J*}}$: constructed using the number of establishments from Quarterly Census of Employment and Wages
3. Controls: lags of shocks and policy room

Empirical responses to monetary policy shocks with policy room

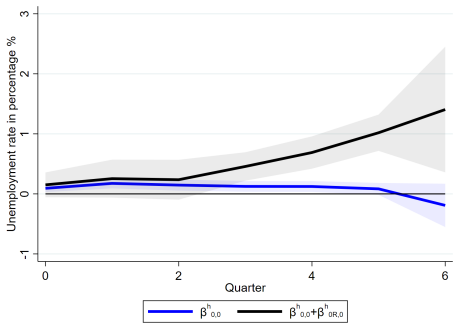
The IRFs display the response (in %) to 1 std (25 basis points) positive monetary policy shock with 1 std (2 percentage points) increase in the log policy room



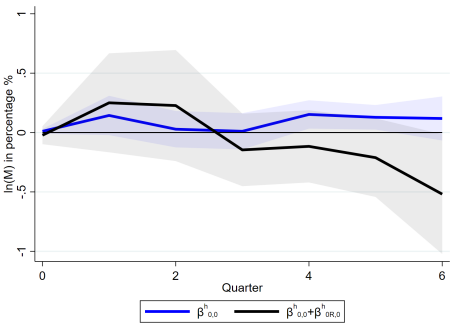
(a) log(Y)



(b) log(C)



(c) Unemployment rate



(d) log(M)

Conclusion

- Develop a tractable model with endogenous firm entry to assess the co-movement of demand and supply
- Identify a Satiation Bound: threshold policy rate that ensures full market participation of firms
- Empirical findings: narrower policy room reduces the extensive margin of monetary policy transmission, leading to a smaller output multiplier and reduced firm entry

The model: calibration

	Parameter Description	Value	Source
β	Discount factor	0.998	Standard.
η	Frisch labor supply elasticity	1	Standard.
γ	Elasticity of substitution (of downstream market)	4.3	From Ghironi and Melitz (2005): 30% markup of price over cost.
σ	Elasticity of substitution (of upstream market)	3	Lower elasticity of upstream market products, as argued in Jones (2011).
α	labor share in the upstream production function	0.6	Standard.
θ	price stickiness	0.75	Standard.
κ	Shape parameter: Pareto distribution of productivity	3.4	Ghironi and Melitz (2005).
ω	Shape parameter: Pareto distribution of fixed cost	3.4	Keep it the same with the productivity distribution.
ϕ_f	Fixed cost - steady state output ratio	0.5547	Estimated
ϕ_g	Government spending - output ratio	18%	Smets and Wouters (2007).
τ_π	Taylor parameter (inflation)	1.5	Standard.
τ_y	Taylor parameter (output)	0.15	Standard.
μ	Long-run TFP growth rate	0.005	Match a yearly growth rate at 2%.
Π	Long-run inflation	1.02	Long-run inflation target at 2%.

Back

The model: calibration extended

	Parameter Description	Value	Source
ρ_a	Autoregression for TFP	0.7071	Excess TFP growth process' half-life of two quarters.
ρ_c	Autoregression for demand shock	0.98	The autocorrelation of the preference shock that affects the marginal utility of consumption estimated by Nakajima (2005).
ρ_g	Autoregression for government spending	0.87	Schmitt-Grohé and Uribe (2007).
ρ_f	Autoregression for fixed cost	0.9011	Estimated.
σ_a	SD for ϵ_a	0.0064	Schmitt-Grohé and Uribe (2007).
σ_c	SD for ϵ_c	0.017	The standard deviation of the preference shock estimated by Nakajima (2005) using U.S. data on consumption, labor, and output is 0.017.
σ_g	SD for ϵ_g	0.016	Schmitt-Grohé and Uribe (2007).
σ_f	SD for ϵ_f	0.0013	Estimated.
σ_r	SD for ϵ_r	0.0025	25 basis points, following Fed practices.

Back

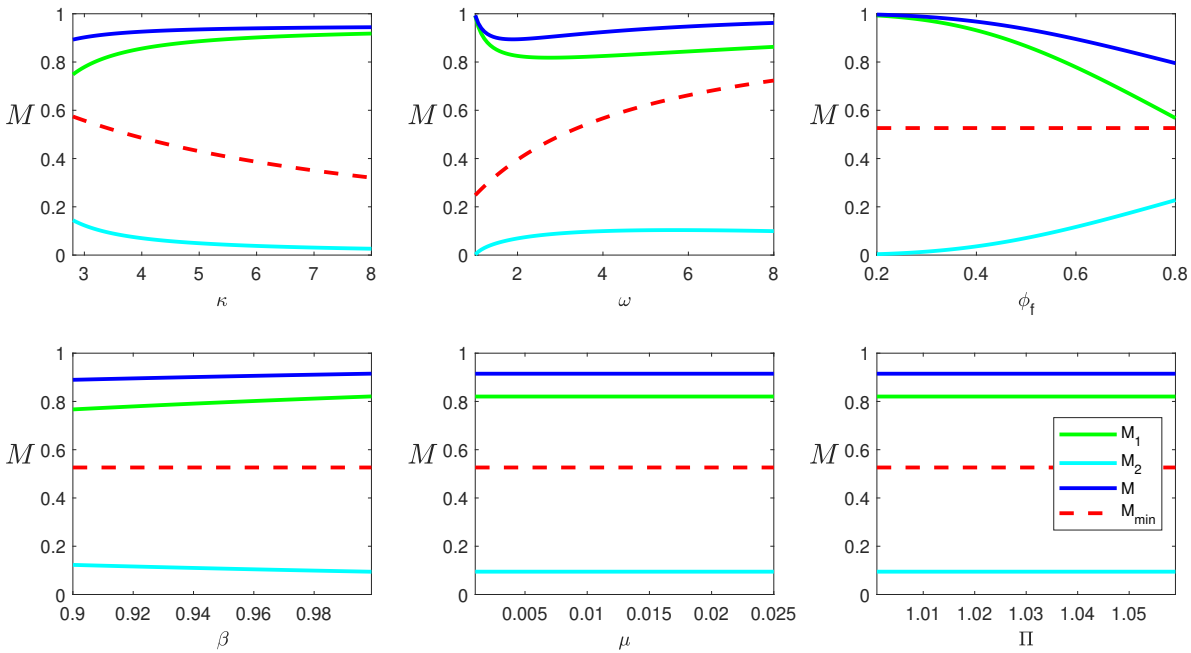
The model: steady states

Variable	Value	Description
H	0.82	Mass of productivity-irrelevant firms.
M	0.91	Mass of firms operating in the market.
R^B	1.012	Gross risk-free rate.
$R^{J,*}$	1.296	Gross satiation rate.
$\tilde{F}^*$	0.72	Cutoff fixed cost-to-output ratio.
Δ	1.0007	Price dispersion.
$\frac{W_t}{P_t A_t}$	0.51	Real wage.
$\frac{C_t}{Y_t}$	0.36	Consumption-to-output ratio.
$\frac{W_t N_t}{P_t Y_t}$	0.6	Labor cost-to-output ratio.
$\frac{L_t / P_t}{\bar{Y}_t}$	0.46	Loan-to-output ratio.

Back

The model: comparative analysis on the share of operating firms

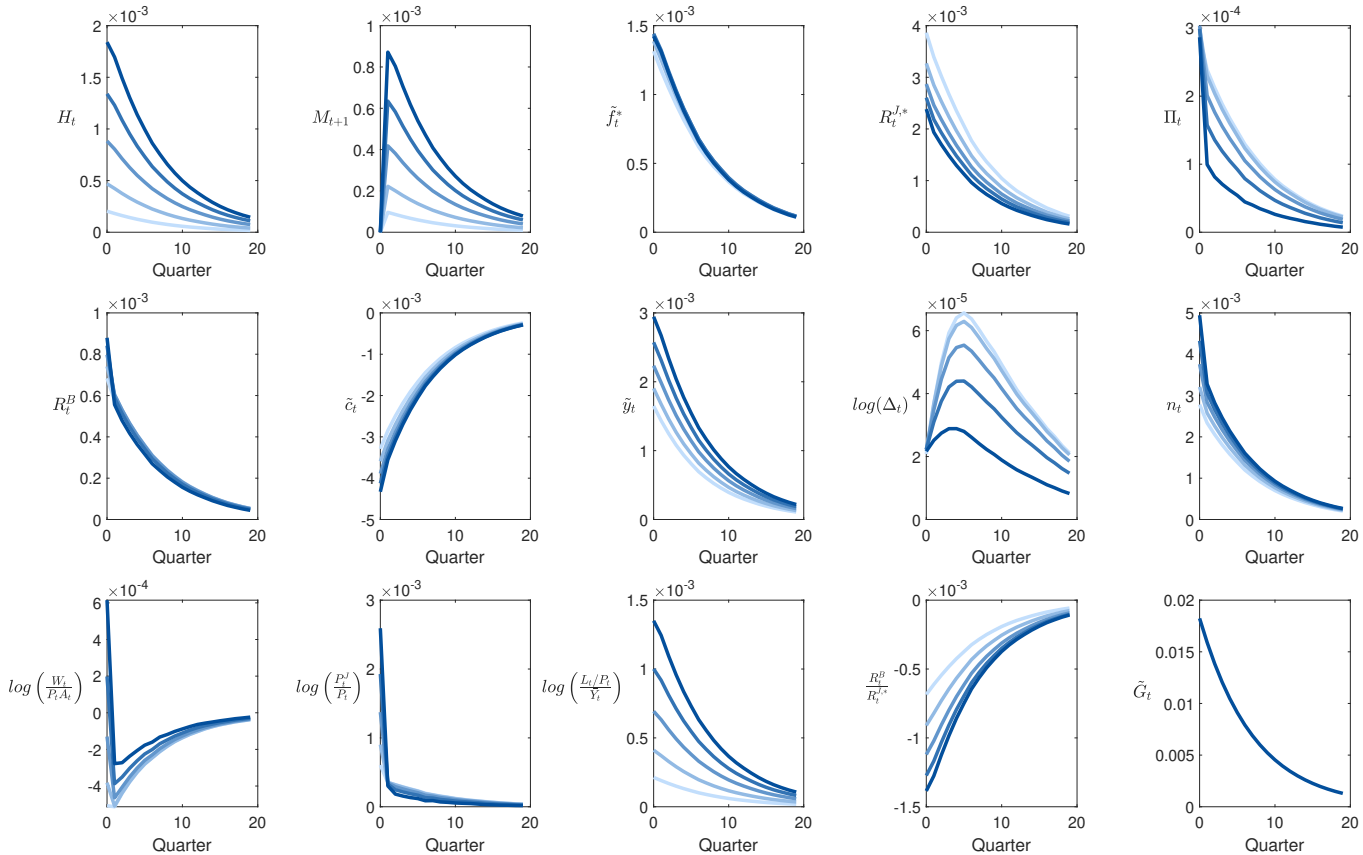
- M_1: share of the firms with low fixed cost always remain active
- M_2: share of firms subject to productivity criteria



1. κ increase the lower bound of productivity ($\uparrow M_1$)
2. ω increase the lower bound of fixed cost ($\downarrow M_1$) and reduce the mass of firms with high fixed cost ($\uparrow M_2$)
3. ϕ_f shift out the fixed cost distribution

Back

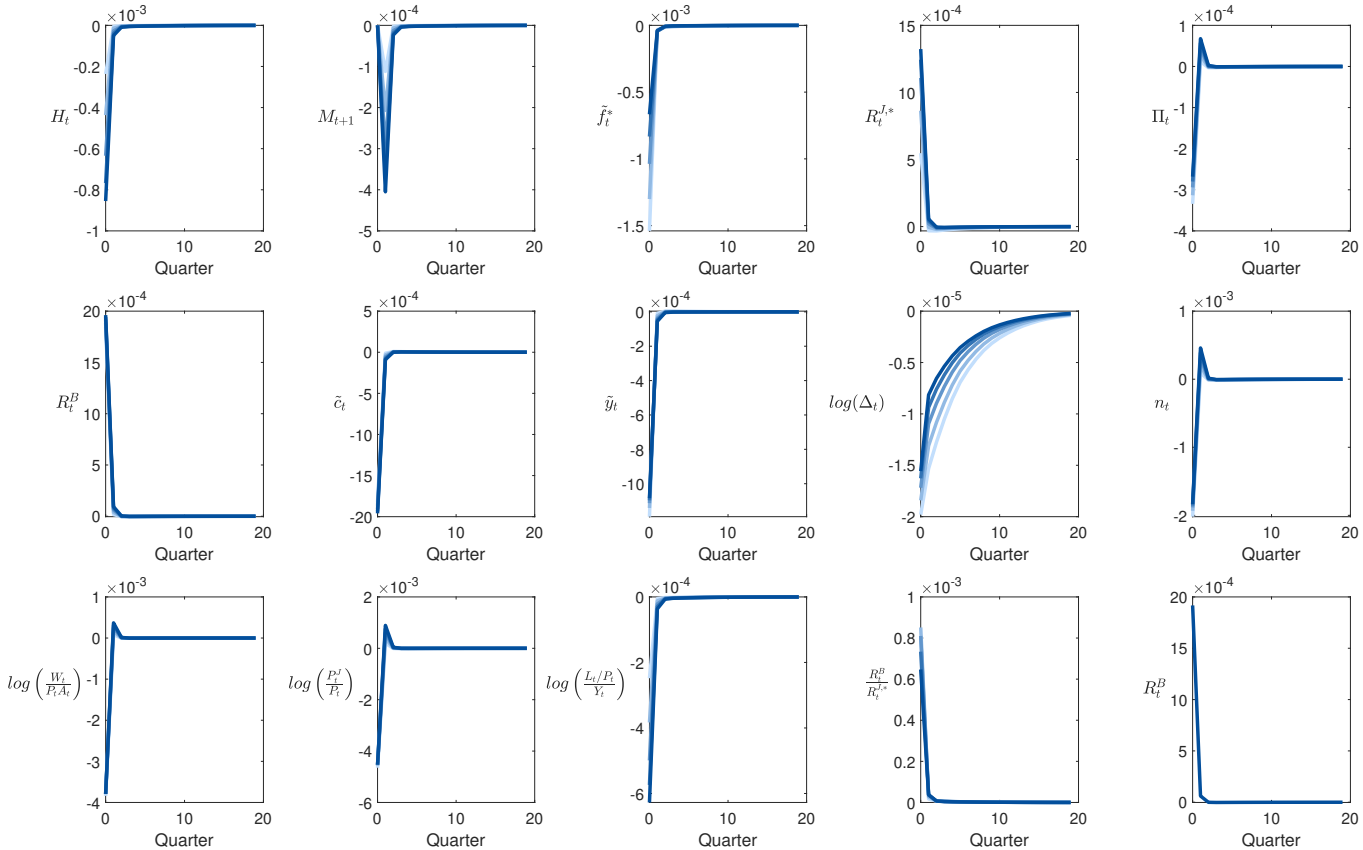
Impulse response function: government spending



Notes: The figures display the deviations for 1 standard deviation (0.016) in $u_{g,t}$. From light blue to dark blue, ϕ_f values are 0.35, 0.45, 0.5547 (benchmark), 0.65, and 0.75)

Back

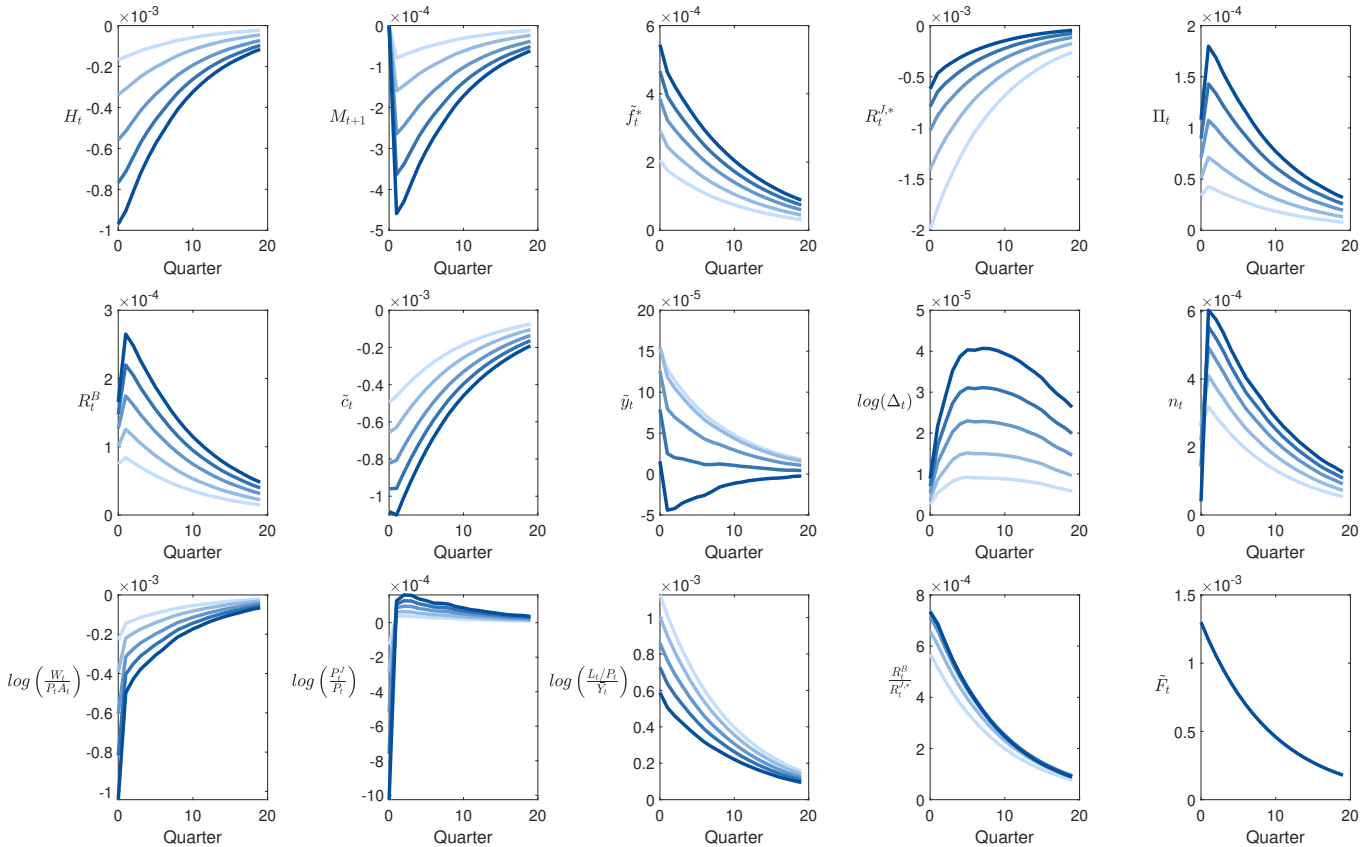
Impulse response function: monetary policy



Notes: The figures display the deviations for 1 standard deviation (0.0025) in $u_{r,t}$. From light blue to dark blue, ϕ_f values are 0.35, 0.45, 0.5547 (benchmark), 0.65, and 0.75)

Back

Impulse response function: fixed cost

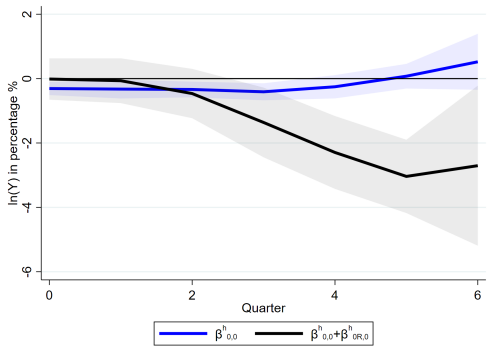


Notes: The figures display the deviations for 1 standard deviation (0.0013) in $u_{f,t}$. From light blue to dark blue, ϕ_f values are 0.35, 0.45, 0.5547 (benchmark), 0.65, and 0.75)

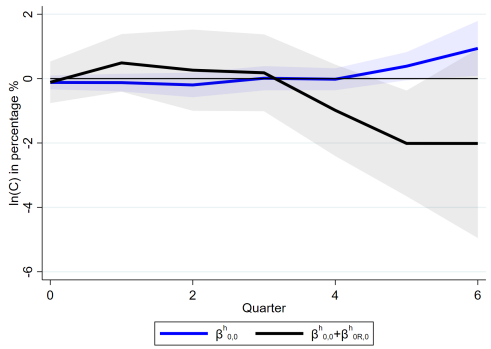
Back

Empirics: robustness check with additional controls

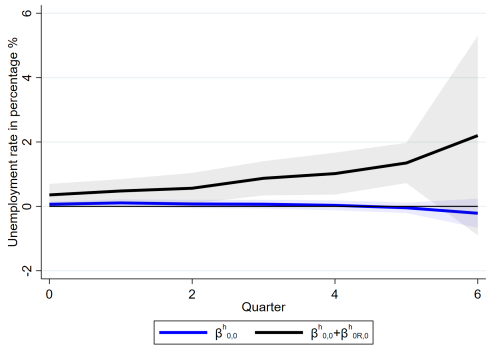
Additional controls: four lags of the oil price growth rate, the long-term interest rate, the consumption growth rate, the GDP deflator, and the shadow federal funds rate from Wu and Xia (2016).



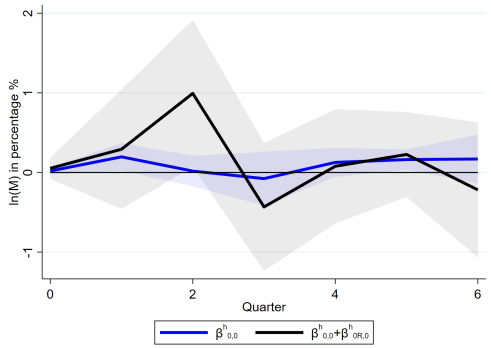
(e) log(Y)



(f) log(C)



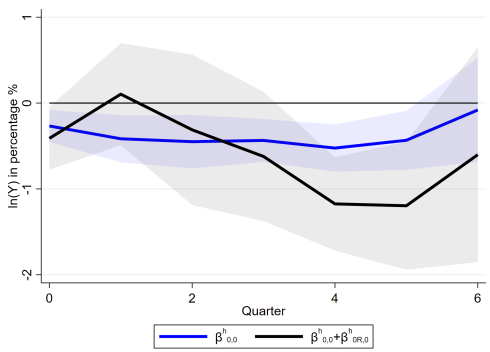
(g) Unemployment rate



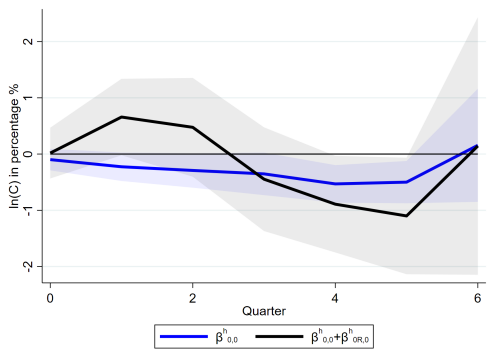
(h) log(M)

Empirics: robustness check with different policy room measure

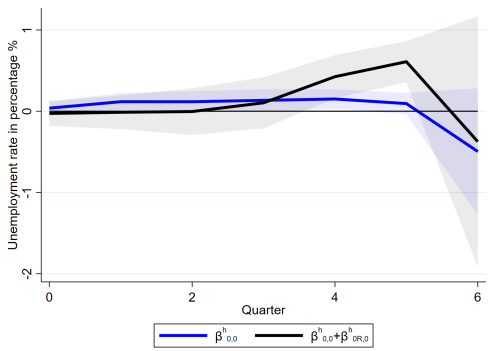
The policy room is measured using methods in Version 1 (see Appendix C.1 and C.4 of the draft) based on the total number of employees from CES National Databases in the Bureau of Labor Statistics (BLS).



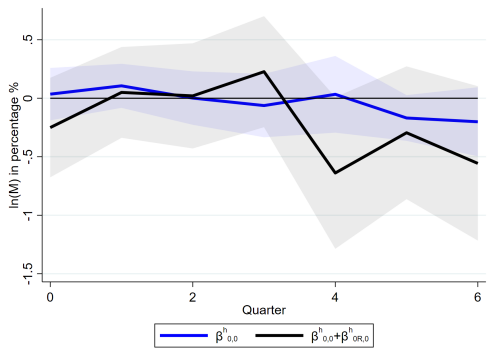
(i) log(Y)



(j) log(C)



(k) Unemployment rate



(l) log(M)