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

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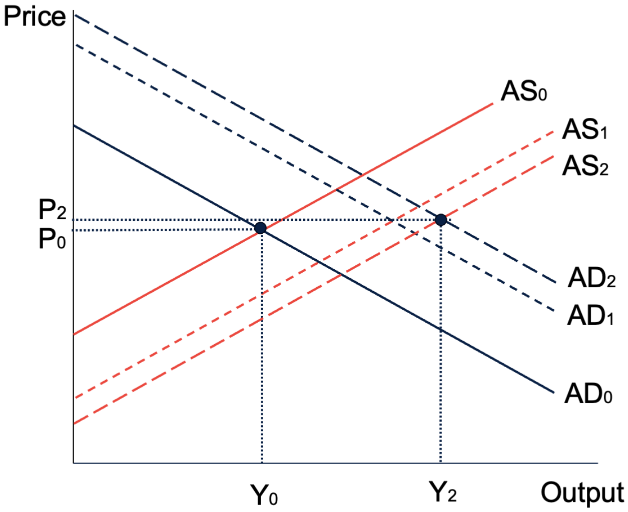
Motivation

- Supply and demand shocks come together during Covid-19 crisis
- Christine Lagarde (2023, Economic Policy Symposium): These shifts – especially those related to the post-pandemic environment and energy, $\cdots$, have restricted aggregate supply while also directing demand towards sectors with capacity constraints. And these mismatches arose, $\cdots$, requiring a rapid policy adjustment by central banks.
- But, are supply and demand shocks separable?

One figure



This paper

A model with endogenous firms entry where

- Two-layer system of firms: bottom-tier (pay fixed cost for entry) and top-tier (nominal rigidity)

- Aggregate demand and supply are intertwined through firm entry

  Monetary tightening $\rightarrow \downarrow$ aggregate demand, worse market condition $\rightarrow \downarrow$ firm entry $\rightarrow \downarrow$ aggregate supply, $\downarrow$ demand from potential entrants $\rightarrow$ worse market condition $\rightarrow \cdots$

- Provide a sufficient statistics for policy room with equilibrium firm entry

Related literature

- Business cycle models with endogenous firm entry
  Bilbiie et al. (2007), Stebunovs (2008), Kobayashi (2011), Bilbiie et al. (2012), Hamano and Zanetti (2017), **Guerrieri et al. (2023)**
  Our paper: suggest the feedback loop and embed it in a simple way

- Empirical work on entry and exit (product scope)
  Monetary shocks: Bergin and Corsetti (2008), Broda and Weinstein (2010), Lewis and Poilly (2012), Uusküla (2016), Colciago and Silvestrini (2022)
  Credit shocks: Ates and Saffie (2021), Ayres and Raveendranathan (2023)
  Our paper: size of the cyclicality depends on policy room

Households

The representative households choose $\{C_t, N_t\}$

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

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 denotes deposit, B_t denotes government bonds, Υ_t denotes lump-sum transfers

Firms

Two layers of firms

- Bottom-tier (indexed by $[m, v]$)
  1. Monopolistic competitive, entry with fixed cost, flexible price
  2. Input: labor
  3. Output: aggregate into intermediate goods
- Top-tier (indexed by $u \in [0, 1]$)
  1. Monopolistic competitive, no entry, Calvo sticky price
  2. Input: intermediate goods
  3. Output: aggregate into final goods

$$\underbrace{\text{Labor } N_{mv,t} \rightarrow J_{mv,t} \xrightarrow{\text{aggregate}} \text{Intermediate good } J_t}_{\text{Bottom-tier}}$$

$$\cdots \rightarrow \underbrace{J_t(u) \rightarrow Y_t(u) \xrightarrow{\text{aggregate}} \text{Final good } Y_t}_{\text{Top-tier}}$$

Firms: bottom-tier

Profit maximization with DRS production function:

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

with $\varphi_{mv,t} \sim$ i.i.d $\mathcal{P}\left(\left(\frac{\kappa-1}{\kappa}\right) A_t, \kappa\right)$, $F_{m,t} \sim$ i.i.d $\mathcal{P}\left(\left(\frac{\omega-1}{\omega}\right) F_t, \omega\right)$

Solutions:

- Productivity cutoff for entry: $\{\varphi^*_{m,t}, \left(\frac{\kappa-1}{\kappa}\right) A_t\}$
- Mass of operating firms: $M_{m,t} = Prob\left(\varphi_{mv,t} \geq \varphi^*_{m,t}\right)$
- Satiated lower bound (SLB) when $M_{m,t} = 1$

$$R^{J,*}_{m,t-1} \equiv \frac{E_{t-1}\left[\xi_t \cdot \Xi_t\right] \left[\left(\frac{\kappa-1}{\kappa}\right) A_t\right]^{\frac{\sigma-1}{\alpha+\sigma(1-\alpha)}}}{P_{t-1} F_{m,t-1}}$$

Details

Firms: bottom-tier

- Loan demand: $\frac{L_{m,t-1}}{P_{t-1}} = M_{m,t} \cdot F_{m,t-1}$
- Full satiation fixed cost threshold when $M_{m,t} = 1$

$$Pr\left(F_{m,t-1} \leq \underbrace{\frac{E_{t-1}\left[\xi_t \cdot \Xi_t\right]\left[\left(\frac{\kappa-1}{\kappa}\right) A_t\right]^{\frac{\sigma-1}{\alpha+\sigma(1-\alpha)}}}{R^J_{t-1} P_{t-1}}}_{\equiv F^*_{t-1}} \right) \equiv H\left(F^*_{t-1}\right)$$

Aggregation:

$$\frac{P^J_t}{P_t} = \left(\frac{W_t}{P_t A_t}\right) \cdot \left(\frac{Y_t \Delta_t}{A_t}\right)^{\frac{1-\alpha}{\alpha}} \cdot \left[\frac{\Theta_3}{1 + \Theta_4 \cdot H\left(F^*_{t-1}\right)}\right]^{\left(\frac{\alpha+\sigma(1-\alpha)}{\alpha(\sigma-1)}\right)}$$

$$\frac{L_{t-1}}{P_{t-1}} = \frac{1}{P_{t-1}} \int_0^1 L_{m,t-1}\, \mathrm{d}m = F_{t-1} \cdot \left[1 - \Theta_L \cdot \left[1 - H\left(F^*_{t-1}\right)\right]^{\left(\frac{\omega-1}{\omega}\right)}\right]$$

Rest of the model

- Shock processes

$$F_t = \phi_f \cdot \tilde{Y} A_t \cdot \exp(u_{f,t}) \qquad \text{with: } u_{f,t} = \rho_f \cdot u_{f,t-1} + \varepsilon_{f,t}$$

$$GA_t \equiv \frac{A_{t+1}}{A_t} = (1+\mu) \cdot \exp\{u_{a,t}\} \qquad \text{with: } u_{a,t} = \rho_a \cdot u_{a,t-1} + \varepsilon_{a,t}$$

$$G_t = \phi_g \cdot Y_t \cdot \exp(u_{g,t}) \qquad \text{with: } u_{g,t} = \rho_g \cdot u_{g,t-1} + \varepsilon_{g,t}$$

- Monetary authority

$$R_t^B = R_t^J = R^J \cdot \left(\frac{\Pi_t}{\Pi}\right)^{\tau_\pi} \left(\frac{Y_t}{\bar{Y}_t}\right)^{\tau_y} \cdot \exp\{\varepsilon_{r,t}\} \qquad \text{with: } \varepsilon_{r,t} \sim N\left(0, \sigma_r^2\right)$$

- Market clearing

$$C_t + \frac{L_t}{P_t} + G_t = Y_t,$$

Calibration

	Parameter Description	Value
κ, ω	Shape parameter of Pareto distributions	3.4
ϕ_f	Fixed cost - steady state output ratio	0.37
γ, σ	Elasticity of substitution	3.79

- κ, ω: standard deviation of log sales and productivity
- ϕ_f: exit rate equals 10%
- γ, σ: Bernard et al. (2003) match the productivity and size advantages of exporters in the US plant-level data.

Other parameters

Steady states

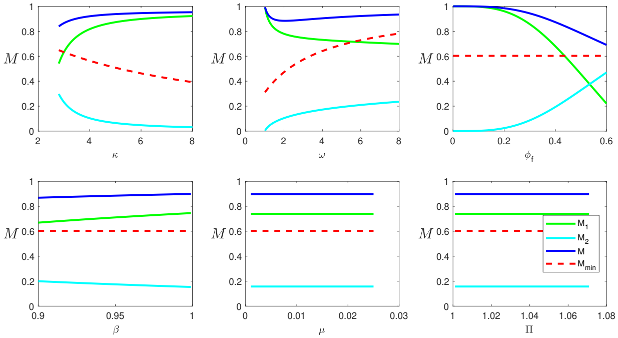
Variable	Value	Meaning
H	0.74	Mass of productivity-irrelevant firms
M	0.9	Mass of firms operating in the market$^{\#}$
R^B	1.02	Gross risk-free rate$^{\#}$
$R^{J,*}$	1.17	Gross satisation rate
$\tilde{F}^*$	0.43	Cutoff fixed cost-to-output ratio
Δ	1.0006	Price dispersion
$\frac{W}{PA}$	0.67	Real wage
$\frac{C}{Y}$	0.52	Consumption-to-output ratio
$\frac{WN}{PY}$	0.7	Labor cost-to-output ratio
$\frac{L}{P\bar{Y}}$	0.3	Loan-to-output ratio

Notes: The variables with subscript $\#$ are matched in calibration

Comparative statics: M

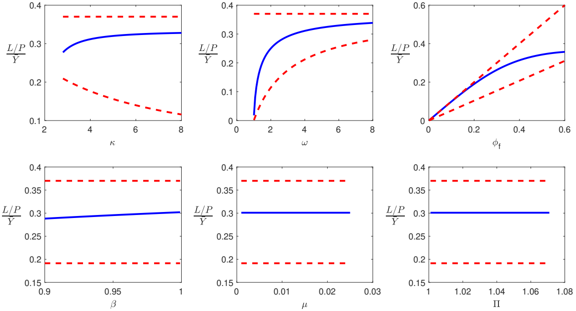
$$M = Prob(F < F^*) + Prob(F > F^*) \int_{F^*}^{\infty} \left(\frac{F_m}{F^*}\right)^{-\frac{\kappa[\alpha+\sigma(1-\alpha)]}{\sigma-1}} \frac{dH(F_m)}{1-H(F^*)}$$

$$= \underbrace{H(F^*)}_{\equiv M_1} + \underbrace{\frac{\omega(\sigma-1)}{\kappa[\alpha+\sigma(1-\alpha)]+\omega(\sigma-1)}(1-H(F^*))}_{\equiv M_2}.$$



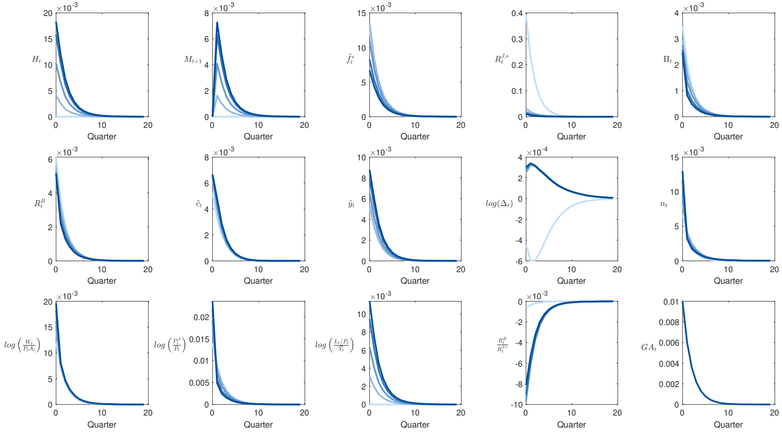
Comparative statics: $\frac{L}{P\bar{Y}}$

$$\frac{L}{P\bar{Y}} = \phi_f \left[1 - \Theta_L (1 - H(F^*))^{\frac{\omega-1}{\omega}}\right] = \phi_f \left[1 - \Theta_L \left(\frac{\omega}{\omega+1}\frac{R^J}{R^{J,*}}\right)^{\omega-1}\right]$$



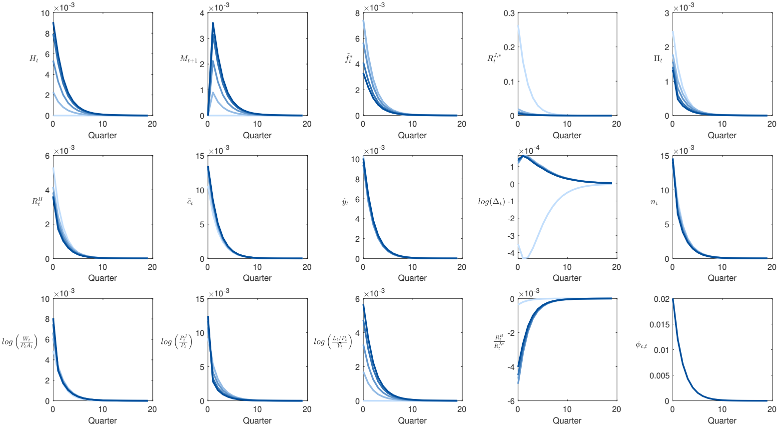
Notes: The red-dashed lines are ϕ_f and $\phi_f(1-\Theta_L)$ correspondingly.

Impulse response functions: TFP shock



Notes: The figures display the deviations for 1 standard deviation (0.01) in $u_{a,t}$. From the light blue to the dark blue, ϕ_fs are 0.02, 0.25, 0.37 (benchmark), 0.5, and 0.6

Impulse response functions: demand shock

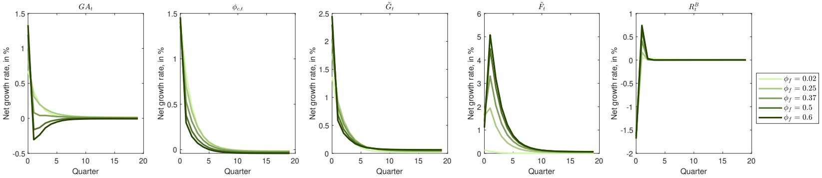


Notes: The figures display the deviations for 1 standard deviation (0.01) in $u_{c,t}$. From the light blue to the dark blue, ϕ_fs are 0.02, 0.25, 0.37 (benchmark), 0.5, and 0.6

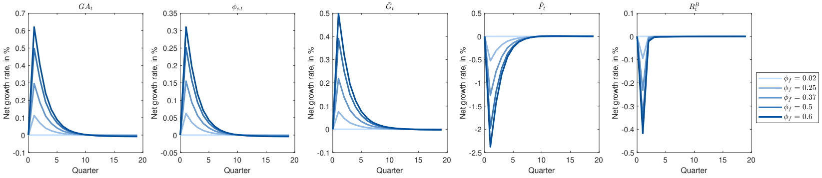
Other shocks

Impulse response functions: intensive vs. extensive

$$g^{N}_{t,t+\iota} \equiv \frac{N_{t+\iota} - N_t}{N_t} = g^{\text{Density}}_{t,t+\iota} + (1 + g^{\text{Density}}_{t,t+\iota}) \cdot g^{\text{Entry}}_{t,t+\iota}$$



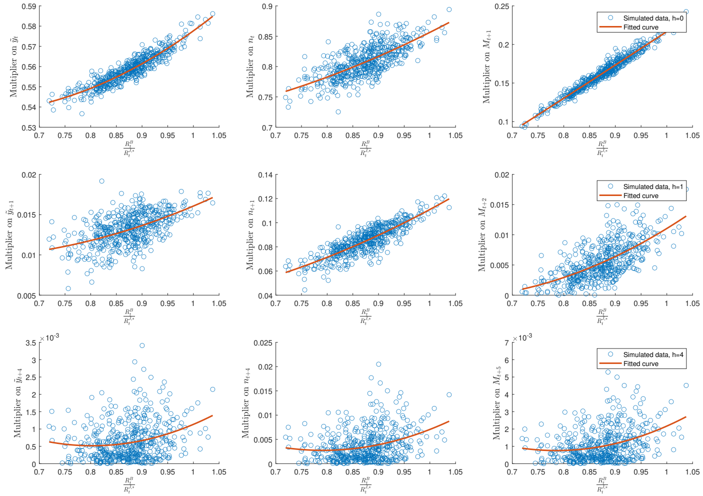
(a) Intensive: g^{Density}



(b) Extensive: g^{Entry}

Multiplier and policy room: monetary policy shock

Multiplier defined by $\frac{|\mathbb{Y}^{\text{shock}}_{t+h} - \mathbb{Y}^{\text{original}}_{t+h}|}{\sigma(\text{shock})}$



Firms: bottom-tier

$$\Pi^J_{mv,t} = \underbrace{\left(1+\zeta^J\right) P^J_{mv,t} J_{mv,t}}_{\equiv r_{mv,t}} - W_t N_{mv,t} - R^J_{t-1} P_{t-1} F_{m,t-1}$$

$$P^J_{mv,t} = \left(\frac{(1+\zeta^J)^{-1}\sigma}{(\sigma-1)\alpha}\right) W_t \varphi_{mv,t}^{-\frac{1}{\alpha}} J_{mv,t}^{\frac{1-\alpha}{\alpha}}$$

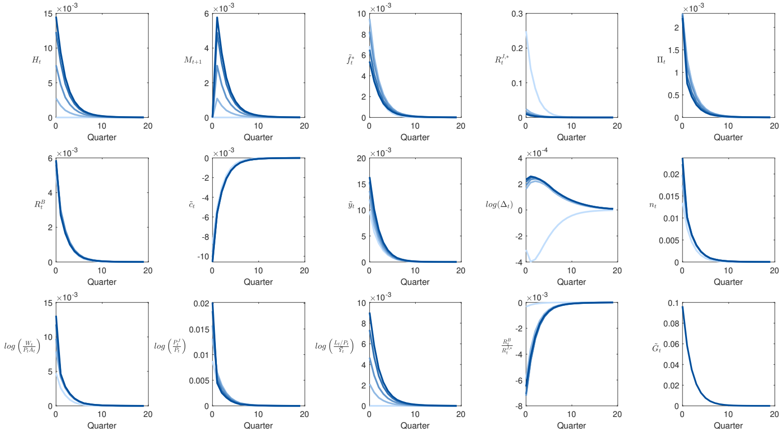
$$\Pi^J_{mv,t} = \Xi_t \cdot \varphi_{mv,t}^{\frac{\sigma-1}{\alpha+\sigma(1-\alpha)}} - R^J_{t-1} P_{t-1} F_{m,t-1}$$

$$\Xi_t \equiv \frac{\alpha+\sigma(1-\alpha)}{(\sigma-1)\alpha} \left(\frac{(1+\zeta^J)^{-1}\sigma}{(\sigma-1)\alpha}\right)^{\frac{-\sigma}{\alpha+\sigma(1-\alpha)}} W_t^{\frac{\alpha(1-\sigma)}{\alpha+\sigma(1-\alpha)}} (\Gamma^J_t)^{\frac{1}{\alpha+\sigma(1-\alpha)}}$$

$$E_{t-1}\left[\xi_t \cdot \Xi_t\right] \cdot \left(\varphi^*_{m,t}\right)^{\frac{\sigma-1}{\alpha+\sigma(1-\alpha)}} - R^J_{t-1} P_{t-1} F_{m,t-1} = 0 \qquad \text{where: } \xi_t = \frac{Q_{t-1,t}}{E_{t-1}\left[Q_{t-1,t}\right]}$$

Back

Impulse response function: government spending



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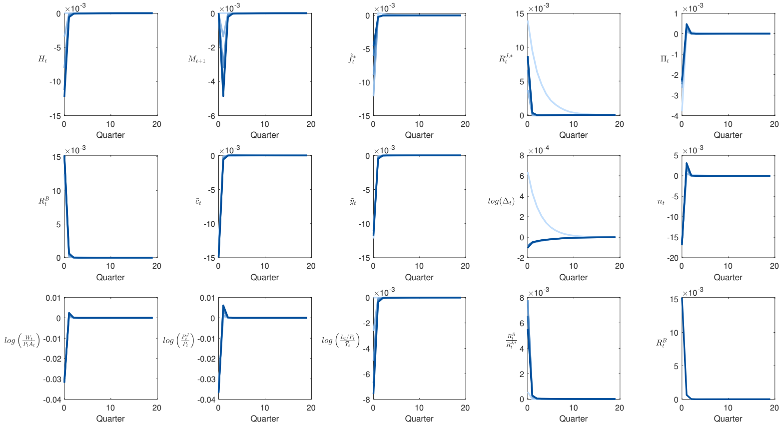
Back

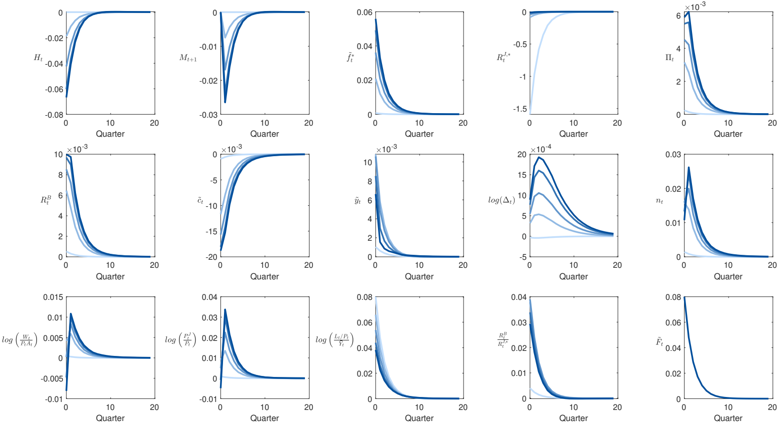
Impulse response function: monetary policy



Notes: The figures display the deviations for 1 standard deviation (0.01) in $u_{r,t}$. From the light blue to the dark blue, ϕ_fs are 0.02, 0.25, 0.37 (benchmark), 0.5, and 0.6

Back

Impulse response function: fixed cost



Notes: The figures display the deviations for 1 standard deviation (0.01) in $u_{f,t}$. From the light blue to the dark blue, ϕ_fs are 0.02, 0.25, 0.37 (benchmark), 0.5, and 0.6