

Aggregate-Demand Amplification of Supply Disruptions: The Entry-Exit Multiplier

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NBER SI: *Impulse & Propagation Mechanisms*
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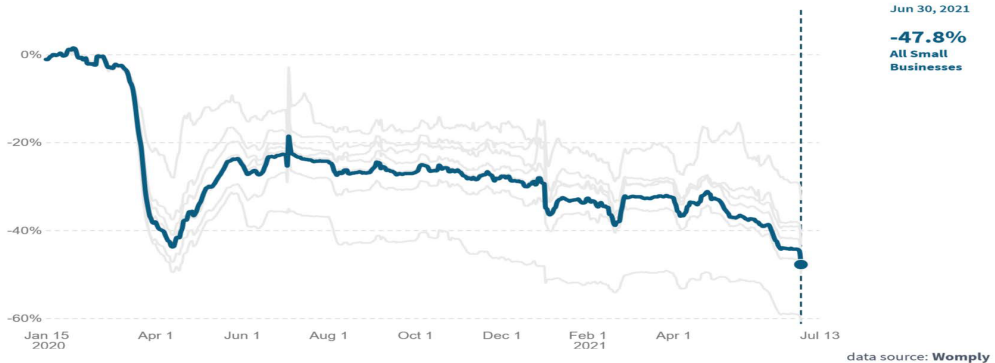
Motivation

- ▶ When/how do nominal rigidities **amplify** supply disruptions (negative supply shocks)?
 - ▶ Inherent feature of business cycle model with **Endogenous Entry-Exit & Variety**
 - ▶ Holds in simplest, pared-down model
- ▶ Application to COVID-19 shock
 - ▶ **Exit: 40%** small businesses *closed* Spring 2020, **48%** still closed
Chetty et al - Opportunity Insights; Crane et al; Kalemli-Ozcan et al
- ▶ Large protracted recession (~12.5%), **negative output gap**
- ▶ Key intuition: Sticky prices distort the extensive margin too

Exit (Closures: Chetty et al, Opportunity Insights)

Percent Change in Number of Small Businesses Open*

In the United States, as of June 30 2021, the number of small businesses open **decreased** by **47.8%** compared to January 2020.



*Change in small businesses open (defined as having financial transaction activity), indexed to January 4-31 2020 and seasonally adjusted. This series is based on data from Womply.

last updated: July 09, 2021 next update expected: July 16, 2021

*Similar: *Homebase* data (Crane et al); estimated exit rate doubled (Kalemli-Ozcan et al) [Results](#)

This Paper

1. **Entry-Exit Multiplier:** Sticky Ps amplify **Agg.-Supply** (TFP) shocks response

$$\text{Multiplier} = \theta > 1 \text{ (Elasticity of Substitution/Demand).}$$

¹+ Complete markets! (Representative agent).

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2. Aggregate-Demand **Amplification** of Aggregate supply disruption $da < 0$

	Effect of TFP decrease on Y (<i>absolute value</i>)		Y Gap
	Flexible Prices	Sticky Prices	
No Entry-Exit ¹	1	≤ 1	≥ 0
Endog. Entry-Exit	$\mathbf{x} > 1$	$\mathbf{X}(da) > \mathbf{x}$	< 0

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3. **Bonus:** entry-exit \rightarrow hours' TFP response **NK~RBC!**

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Literature

▶ **Entry-Exit & Variety: Business Cycles** (2000s)

- ▶ Bilbiie Ghironi Melitz (2012 JPE); Jaimovich Floetotto; Colciago Etro; Lewis Poilly; Clementi Pallazzo; Lee Mukoyama; Dixon Savagar; Cacciatore Fiori; Hamano Zanetti; Edmond Midrigan Xu; Sedlacek Sterk; Gutierrez Philippon; Carvalho Grassi; Michelacci Paciello Pozzi; **90s**: Chatterjee Cooper; Devereux Head Lapham; Cook; Kim

▶ **Entry-Exit & Variety w/ Nominal Rigidities: Monetary Policy**

- ▶ Bilbiie Ghironi Melitz (2007 NBER MA); Bergin Corsetti, Bilbiie Fujiwara Ghironi; Etro Rossi; Bilbiie (2019), Cacciatore Fiori Ghironi; Colciago Silvestrini, Hamano Zanetti, ...

▶ **COVID-19 Recession:**

- ▶ Guerrieri Lorenzoni Straub Werning; Woodford; Baqaee Farhi; Fornaro Wolf; Basu et al; Auerbach et al; Cesa-Bianchi Ferrero
- ▶ different: **aggregate** supply shock (TFP) + **endogenous** entry-exit, GE intensive+**extensive**→aggregate C; **complementary**: goods (*disaggregated*) vs sectors

▶ **TFP & hours: NK vs RBC**

- ▶ Galí; Chari Kehoe McGrattan; Basu Fernald Kimball; Christiano Eichenbaum Vigfusson; Alexopoulos; Galí Rabanal; Peersman Straub; Foroni Furlanetto Lepetit; Cantore Leon-Ledesma McAdam Willman

Endogenous Entry-Exit NK Model: Simplest, Static

- ▶ CES $Y_t = \left(\int_0^{N_t} y_t(\omega)^{\frac{\theta-1}{\theta}} d\omega \right)^{\frac{\theta}{\theta-1}}$, $\theta > 1$ ES across ω

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- ▶ Simplest AD, static; **money** $M_t = P_t Y_t$ (generalize to Euler eq + Taylor rule)

The Entry-Exit Multiplier

► Proposition: The Entry-Exit Multiplier

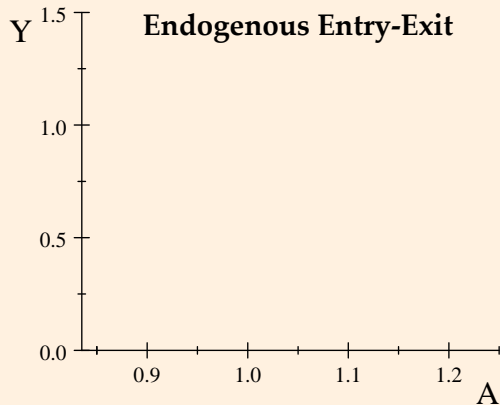
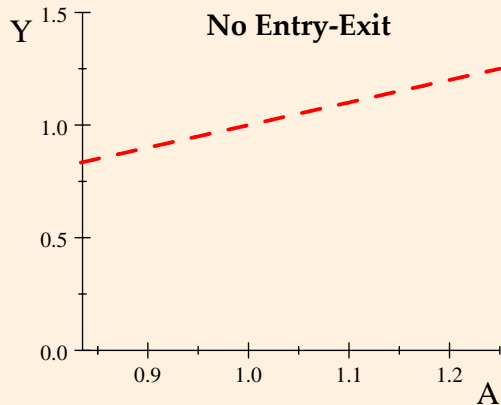
$$N_t^{EF} = \frac{1}{\theta} \frac{A_t \bar{L}}{f} \quad \text{vs} \quad N_t^{ES} = \frac{A_t \bar{L}}{f} - \frac{M_t}{f \bar{p}}$$

$$\implies \frac{d \log N_t^{ES}}{d \log A_t} > \frac{d \log N_t^{EF}}{d \log A_t}$$

- Intuition: $A \downarrow$; F: prices \uparrow & exit, **both** intensive & extensive
- S: stuck with too low $p \rightarrow$ loss \rightarrow exit \rightarrow endog. "productivity" (variety) \downarrow
 - adjustment disproportionately born by **extensive** margin
 - Firms too few & large = distortion
- more plausible for **negative** (large) shocks; inability to $\uparrow p$ in slump
- sticky p : Reduced form friction \sim inability to contract despite loss \rightarrow exit

The Entry-Exit Multiplier \rightarrow AD Amplification?

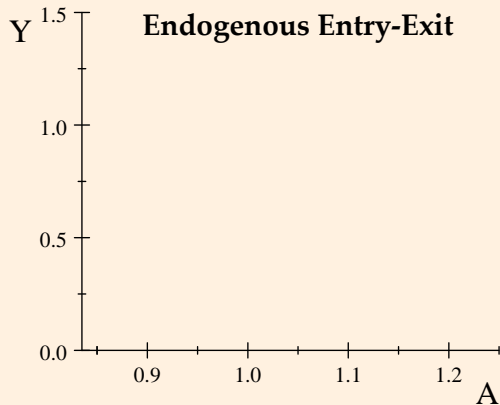
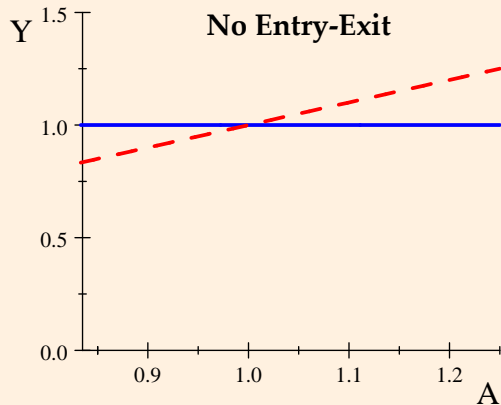
Mind the nonlinearity!



Y^F (flex. prices) red dash, Y^S (sticky prices) solid blue

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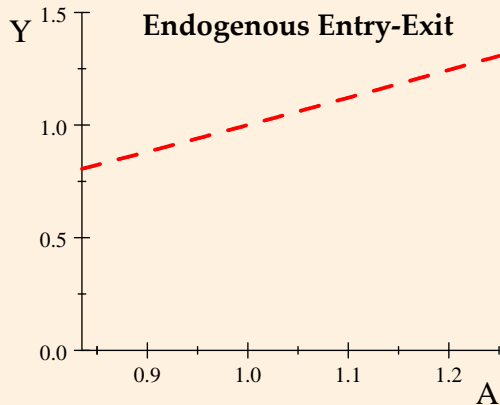
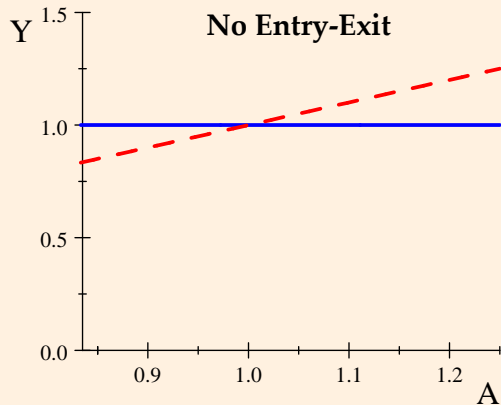
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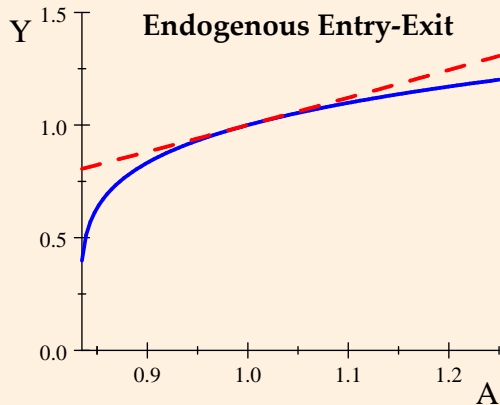
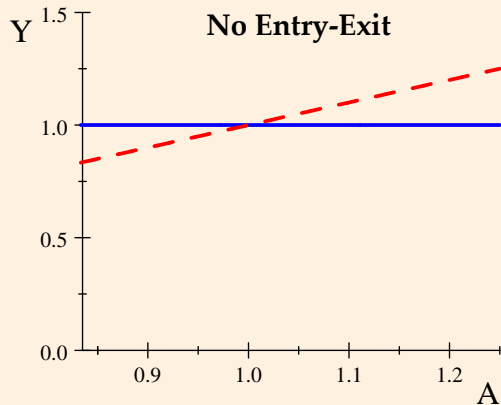
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The Entry-Exit Multiplier \rightarrow AD Amplification?

Proposition To 2nd order (x log-dev. of X):

$$y_t^{EF} \simeq \frac{\theta}{\theta - 1} a_t + \frac{1}{2} \frac{\theta}{(\theta - 1)^2} a_t^2$$

$$y_t^{ES} \simeq \frac{\theta}{\theta - 1} a_t + \frac{1}{2} \frac{\theta^2 (2 - \theta)}{(\theta - 1)^2} a_t^2$$

$$\rightarrow \text{Output gap: } y_t^{ES} - y_t^{EF} \simeq -\frac{1}{2} \theta a_t^2$$

- ▶ **Always negative** (Second-order): \downarrow more w/ $A \downarrow$.
- ▶ Large **negative** shocks \rightarrow S response much larger.
- ▶ First-order **identical** (neutrality proposition Bilbiie, 2019)

The Entry-Exit Multiplier \rightarrow AD Amplification?

- ▶ **Key:** $Y(N)$ nonlinear, amplifies A higher-order (N linear in A)

$$Y_t = N_t^{\frac{\theta}{\theta-1}} \left(\frac{A_t \bar{L}}{N_t} - f \right) \rightarrow y_t \simeq -\frac{1}{2} \frac{\theta}{(\theta-1)^2} n_t^2$$

- ▶ N amplification to (negative) $A \rightarrow Y$ amplification by concavity
- ▶ decreasing with benefit of input variety $\frac{1}{\theta-1}$
- ▶ crucial for extensive vs intensive, distorted w/ sticky p
- ▶ more intensive desirable but unfeasible, *less* important w/ closer substitutes:
 - ▶ θ larger, less benefit of variety, less distortion.
- ▶ θ determines **both** entry-exit multiplier & concavity, opposite effect
- ▶ Net effect of $\theta =$ **amplify gap** (disentangle later)

Quantitative (Nonlinear) Model

- ▶ Rotemberg pricing, ψ adjustment cost param. $C_t = (1 - \frac{\psi}{2}\pi_t^2)Y_t$:

$$(1 + \pi_t)\pi_t = \beta E_t \left[\left(\frac{C_t}{C_{t+1}} \right)^{\frac{1}{\sigma}} \frac{N_t}{N_{t+1}} \frac{Y_{t+1}}{Y_t} (1 + \pi_{t+1})\pi_{t+1} \right] + \frac{\theta}{\psi} \left[\frac{1}{\mu_t} - \frac{\theta - 1}{\theta} \left(1 - \frac{\psi}{2}\pi_t^2 \right) \right]$$

- ▶ $1 + \pi_t \equiv p_t/p_{t-1}$ and $1 + \pi_{C,t} \equiv P_t/P_{t-1}$:

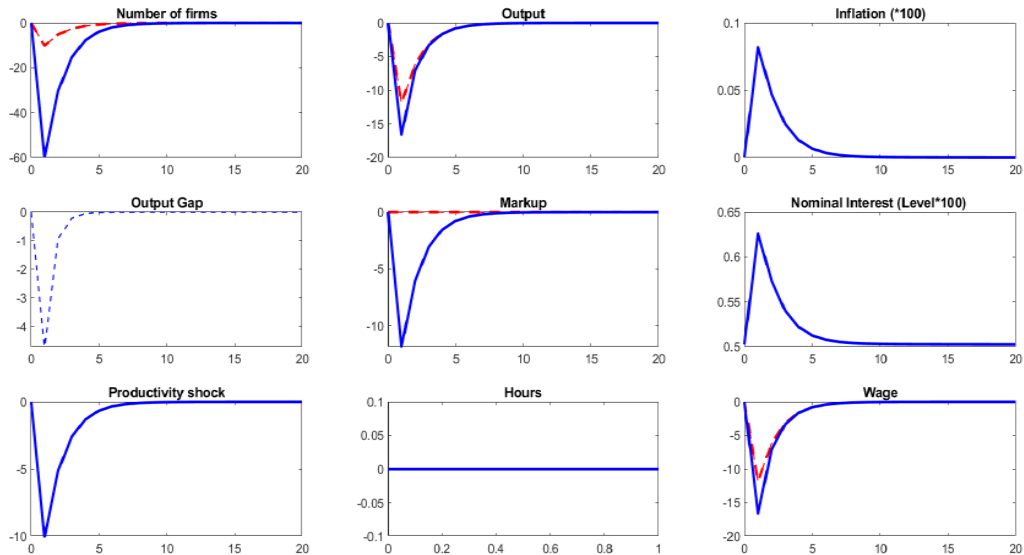
$$\frac{1 + \pi_t}{1 + \pi_{C,t}} = \left(\frac{N_t}{N_{t-1}} \right)^{\frac{1}{\theta-1}}.$$

- ▶ AD relevant: CPI $\pi_t^C \rightarrow$ intertemp. subst. Euler:

$$C_t^{-\frac{1}{\sigma}} = \beta E_t \left(\frac{1 + I_t}{1 + \pi_{C,t+1}} C_{t+1}^{-\frac{1}{\sigma}} \right).$$
$$1 + I_t = \beta^{-1} (1 + \pi_t)^\phi$$

- ▶ Param.: $U = \ln C - .5L^2$, CES $\theta = 3.8$, PC slope ~ 0.01 ; $\phi = 1.5$, A persist. $.5$

Quantitative (Nonlinear) Model



Flexible (red dash) and Sticky (solid blue) prices.

Bonus: Entry Solves NK-RBC Hours Controversy

- ▶ known controversy: hours countercyclical wrt TFP shocks in NK
- ▶ RBC: opposite, and indeed central ingredient
- ▶ NK + **Entry-Exit** → convergence
 - ▶ NK response driven by income effect of profits. Entry-exit eliminates that
- ▶ Best illustrated w/ GHH preferences (η inverse labor elasticity)

$$l_t^{NF} = \eta^{-1} a_t \neq l_t^{NS} = -\theta a_t$$
$$l_t^{EF} = l_t^{ES} = \frac{\theta}{\eta(\theta - 1) - 1} a_t$$

Same response (with CES)

First-order AD Amplification w/ Entry-Exit Multiplier

- ▶ External returns $Y_t = N_t^\lambda \times CES; \rho_t = N_t^{\lambda + \frac{1}{\theta-1}}, \lambda > 0$
- ▶ Planner $N_t^{opt} / N_t^{EF} = 1 + \lambda (\theta - 1) / \left(\lambda + \frac{\theta}{\theta-1} \right) \rightarrow$ **too little** entry when $\lambda > 0$
- ▶ **Key: Entry-Exit Multiplier + Inefficiency \rightarrow AD amplification**

$$y_t^{ES} - y_t^{EF} = \lambda (\theta - 1) a_t + \frac{1}{2} \left(\lambda + \frac{1}{\theta - 1} \right) \left[\lambda (\theta^2 - 1) + \theta - \theta^2 \right] a_t^2$$

$$y_t \simeq \lambda n_t + \frac{1}{2} \left(\lambda + \frac{1}{\theta - 1} \right) \left(\lambda - \frac{\theta}{\theta - 1} \right) n_t^2.$$

- $\lambda > 0 \Leftrightarrow \frac{dY}{dN} > 0$: higher "indirect effect" of A on Y through N
- disentangle benefit of input variety $\lambda + \frac{1}{\theta-1}$ & elast. subst. θ for curvature

- ▶ \rightarrow **3-Equation NK model w/ Entry-Exit** (textbook-isomorphic): see paper

Intertemporal vs Inter-good Substitution: CRRA utility

- ▶ C CES aggregate, labor inelastic (*general: paper*)

$$U(C) = \frac{C^{1-\frac{1}{\sigma}} - 1}{1 - \frac{1}{\sigma}}$$

$\ln C_t$ limit as $\sigma \rightarrow 1$

- ▶ σ elasticity of *intertemporal* substitution

Intertemporal vs Inter-good Substitution: CRRA utility

- ▶ Entry-exit multiplier

$$n_t^{ES} = \frac{\theta}{\sigma} a_t = \frac{\theta}{\sigma} n_t^{EF}.$$

- ▶ Output gap (first-order zero, CES envelope):

$$y_t^{ES} - y_t^{EF} \simeq -\frac{1}{2} \left(\frac{\theta}{\sigma} - 1 \right) \frac{\theta}{\theta - 1} a_t^2.$$

Both entry-exit multiplier *and* AD amplification condition (restriction w/ lnC):

$$\underset{\in [4,8]}{\theta} > \underset{\in [0,2]}{\sigma} \Leftrightarrow \underline{\text{substitutability}}$$

- ▶ Guerrieri Lorenzoni Straub Werning: (looks) **opposite!** is it?
- ▶ **Complementary** mechanisms, coexist & reinforce each other:
 - ▶ here, disaggregated (goods) subst., GLSW aggregate, sectoral-level complementarity

Conclusion

- ▶ *A simple theory of supply-driven demand shortages*
 1. **Entry-Exit Multiplier** (of Supply Shocks) w/ Sticky prices
 2. **Aggregate Demand** amplification (curvature, inefficiency w/ ext. returns)
- ▶ **Plausible** condition: more willing to *substitute* between goods than over time
- ▶ Solves an **NK-RBC controversy**: same-sign hours response to TFP
- ▶ **Stabilization policy implication**: subsidize entry/prevent exit
- ▶ **Follow-up** work: persistence, hysteresis, heterogeneity.