# Going Public over the Business Cycle

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# Motivation

"For business owners who want to take their companies to the next level, this bill will **make it easier for you to go public**. And that's a big deal because **going public is a major step towards expanding and hiring more workers**."

Source: *Remarks by President Obama at JOBS Act Bill Signing* (April 5th, 2012)

**What does going public mean?**

- *Private* firms become *public* as they begin trading shares in the public stock market
- Firms typically go public through an Initial Public Offering (IPO)

# Motivation

- **Empirical evidence shows that IPOs increase employment at firm level**

  (Borisov, Ellur, and Sevilir, 2021)

  → Raise capital via IPO → Invest → Expand

- **IPO activity aligns closely with the business cycle**

  → It is well-established that the number of IPOs is procyclical ◂ Figure

  → The amount of capital raised via IPO changes across the business cycle

- **The timing of an IPO matters for post-IPO employment growth**

  → Firms going public during recessions experience **persistently slower growth**

# Research questions

**What are the cyclical determinants of IPO decisions?**

**How does the cyclicality of IPOs matter for aggregate employment dynamics?**

$\Rightarrow$ Job creation margin during economic downturns

# What I do

- **Provide new empirical facts on IPO cyclicality**
  - → Use U.S. public firm data
  - → Analyze differences between IPO firms during expansions and contractions
  - → Provide evidence for differences in selection, capital raised, post-IPO growth
- **Build a dynamic model of heterogeneous firms**
  - → Endogenous decisions on entry, exit, IPO, debt, investment, and employment
- **Calibrate the model to the U.S. economy**
- **Simulate recovery process from a negative shock on aggregate productivity**
  - → Quantify the role of IPO cyclicality on aggregate employment response

# Literature and contributions

- **Cyclical IPOs** Empirics (Helwege and Liang (2004), Tran and Jeon (2011), Angelini and Foglia (2018))

  Theory (Alti (2005), Pastor and Veronesi (2005), Aghamolla and Guttman (2021))

  → Analyze the **consequences** using **heterogeneous firm dynamics** model

- **IPO decision and firm dynamics** Firm dynamics over the business cycle (Lee (2005), Choi (2014), Lee and Mukoyama (2015), Sedlacek (2015), Clementi and Palazzo (2016), Moreira (2016), Sedlacek and Sterk (2017))

  Endogenous IPO choice (Clementi (2004), Gonzalez (2021), Casella, Lee and Villavazo (2023))

  → Identify the **role of IPOs** in firm dynamics over the **business cycle**

- **Capital misallocation over the business cycle** (Kiyotaki and Moore (1997), Jermann and Quadrini (2012), Khan and Thomas (2013), Gopinath, Kalemli-Ozcan, Karabarbounis, and Villegas-Sanchez (2017))

  → Examine the misallocation driven by the **dynamics between private and public firms**

# Empirical evidence

# Data

- **Compustat/CRSP**
  - → Panel data based on the financial reporting of public firms in the U.S.
  - → Sample: 1980 - 2019

    ... $\sim$ 110,400 firm-year observations ◂ Sample selection

    ... $\sim$ 10,900 number of IPOs

- **Timing of IPO is identified by IPO dates**
  - → Define cohorts: **Expansion** (trough-peak) and **Contraction** (peak-trough)

# Descriptive statistics

**Median, at the IPO**

| | Expansion | Contraction |
|---|---|---|
| Debt-to-assets ratio | 0.41 | 0.44 |
| Industry | | |
| Mining | 0.06 | 0.12 |
| Manufacturing | 0.47 | 0.46 |
| Service | 0.47 | 0.42 |
| Employment (1K) | 0.20 | 0.13 |
| Assets (1M, $) | 2,575 | 470 |
| Sale of stock (1M, $) | 622.60 | 54.41 |
| relative to Assets | 0.35 | 0.12 |

- **No significant differences** in ...
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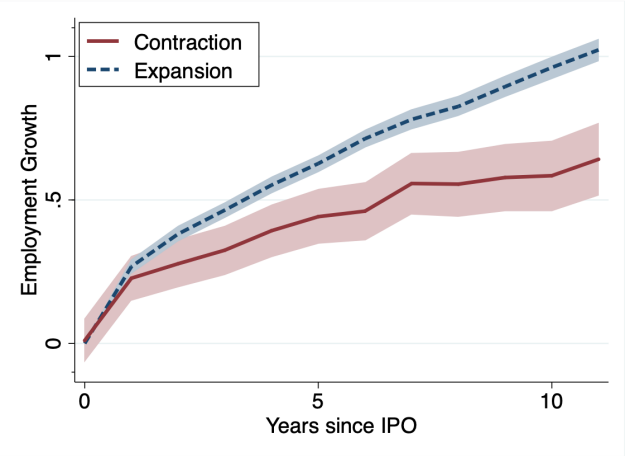
- **Selection in size**
  - → **Contraction** cohort is smaller
- **Cyclical capital injection**
  - → **Contraction** cohort raises less capital through IPOs Regression

# Heterogeneous Post-IPO growth




**Contraction cohort grows persistently slower!**

**What drives this growth disparity?**

- **Different exit patterns?** Exit rate
- **Cyclical capital injection?**

(Controls: Pre-IPO size / sales per worker / capital intensity / debt to asset, detrended GDP) Equation

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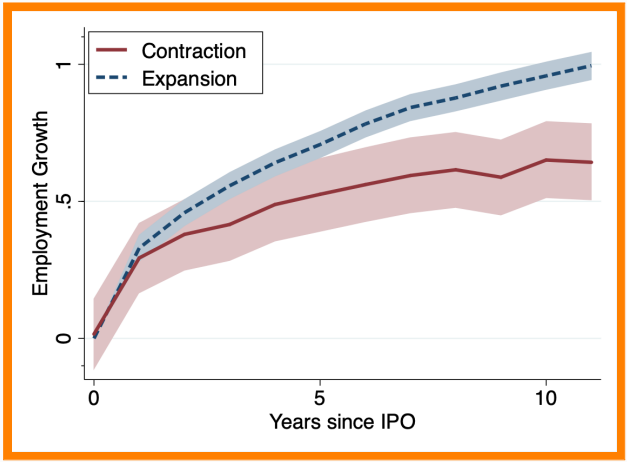


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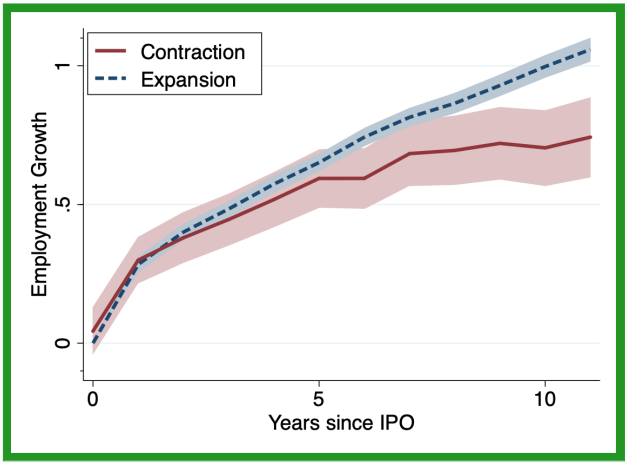


**Contraction cohort grows persistently slower!**

**What drives this growth disparity?**

- **Different exit patterns?** Exit rate
  - → Balanced panel
- **Cyclical capital injection?**
  - → Control for the **sales of stock** in the IPO year

(Controls: Pre-IPO size / sales per worker / capital intensity / debt to asset, detrended GDP) Equation

# IPO Cyclicality

- Procyclical number of IPOs
- IPO firms during **contractions** ...
  - → **are smaller** (different selection)
  - → **raise less capital** (capital injection cyclicality)
  - → **grow persistently slower after the IPO** (heterogeneous post-IPO growth)
- **Next step**
  - → Develop **heterogeneous firm dynamics model** with **business cycle**
    - Financial frictions + Competitive labor market
    - Endogenous entry/exit
    - **Endogenous transition** from private to public through **IPO decisions**

# The model

# Environment

- Discrete time and infinite horizon
- **Potential entrants** and **incumbent private and public firms** make decisions
  - → Entry,

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# Environment

- Discrete time and infinite horizon
- **Potential entrants** and **incumbent private and public firms** make decisions
  - → Entry, exit, employment, investment, borrowing, and IPO
- **Production technology** using capital $k_t$ and labor $l_t$

$$y_t = z_t s_t (k_t^{\alpha} l_t^{1-\alpha})^{\eta}$$

  - → **Aggregate productivity** $\log(z_{t+1}) = \rho_z \log(z_t) + \varepsilon_{z,t}, \;\; \varepsilon_{z,t} \sim \mathcal{N}(0, \sigma_z)$
  - → **Idiosyncratic productivity** $\log(s_{t+1}) = \rho_s \log(s_t) + \varepsilon_{s,t}, \;\; \varepsilon_{s,t} \sim \mathcal{N}(0, \sigma_s)$

# Financial frictions

- **Firms** finance their operations through **borrowing**, and **private firms** can also **raise capital via IPOs**
- **Debt financing ($b_t$)**
  - → Borrow at the interest rate $r(z_t)$ ◂ Specification
  - → Subject to the collateral constraint: $b_t \leq \theta k_t$, where $\theta \in \{\theta^{pr}, \theta^{pb}\}$
    - ... Firms may not allocate their resources efficiently
- **Initial Public Offering**
  - → **Financially constrained private firms** can raise capital from the public stock market

# Initial Public Offering

- **Incur a fixed IPO cost** $\kappa$ (one-time cost)
- **Sell** $\chi$ **share of their equity in the public stock market at price** $p(k_t, b_t, s_t, z_t)$

$$\chi p(k_t, b_t, s_t, z_t) = \mathbb{E}_t\Big[M(z_t, z_{t+1}) \max\{(\chi D_{t+1} + \chi p(k_{t+1}, b_{t+1}, s_{t+1}, z_{t+1})), \chi L_{t+1}\}\Big]$$

→ IPO firms **receive** a capital injection at $t$

- It reflects investors' expected future cash flows ($D_{t+1}$: dividend, $L_{t+1}$: liquidation)
- It is discounted using **procyclical** stochastic discount factor ◂ Specification

→ From $t+1$, $\chi$ share of public firms belongs to public investors

- Dividend payment to public investors

# Initial Public Offering

- **Public firms are required to make regular disclosures**
  - → Higher operating costs (recurring cost): $f^{pb} > f^{pr}$
  - → Easier debt financing: $\theta^{pb} > \theta^{pr}$ ⇒ **more efficient resource allocation!**

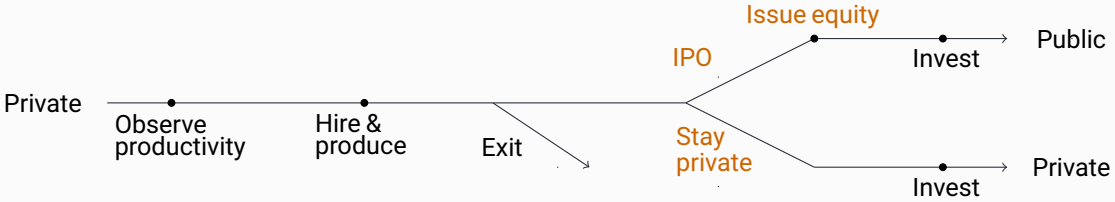
- **Trade-off at IPO decision**

| Costs | Benefits |
|---|---|
| IPO cost $\kappa$ | Capital injection $\chi p(k_t, b_t, s_t, z_t)$ |
| Higher operating costs $f^{pb} > f^{pr}$ | Relaxed collateral constraint $\theta^{pb} > \theta^{pr}$ |

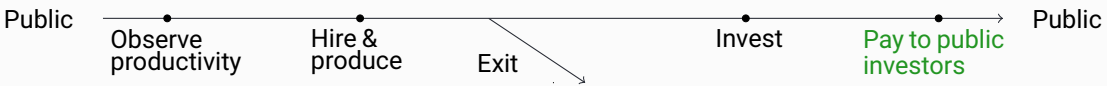
→ **The amount of capital injection depends on the aggregate state!**

# Timeline

- **Private firm**




- **Public firm**



# Value function: Public firms

- $\mathcal{S} = (s, z, a)$ where $a \equiv k - b$
- $V^{pb}(\mathcal{S}) = \max\{\tilde{V}^{pb}(\mathcal{S}), V^{x,pb}(\mathcal{S})\}$

**Operating**: $\tilde{V}^{pb}(\mathcal{S}) = \max_{a'} \quad (1-\chi)d + \mathbb{E}[M(z,z')V^{pb}(\mathcal{S}')|\mathcal{S}]$

s.t. $d + a' = \underbrace{y - wl - (r+\delta)k - f^{pb}}_{\pi(\mathcal{S})} + (1+r)a, \quad k \leq \frac{a}{1-\theta^{pb}}, \quad d \geq 0$

**Exit**: $V^{x,pb}(\mathcal{S}) = (1-\chi)[\pi(\mathcal{S}) + (1+r)a]$

# Value function: Private firms

- $V^{pr}(\mathcal{S}) = \max\{\tilde{V}^{pr}, \tilde{V}^{ipo}, V^{x,pr}\}$

**Stay private**: $\tilde{V}^{pr}(\mathcal{S}) = \max_{a'} \; d + \mathbb{E}[M(z,z')V^{pr}(\mathcal{S}')|\mathcal{S}]$

$$\text{s.t. } d + a' = y - wl - (r+\delta)k - f^{pr} + (1+r)a, \quad k \leq \frac{a}{1-\theta^{pr}}, \quad d \geq 0$$

**IPO**: $\tilde{V}^{ipo}(\mathcal{S}) = \max_{a'} \; d + \mathbb{E}[M(z,z')V^{pb}(\mathcal{S}')|\mathcal{S}]$

$$\text{s.t. } d + a' = y - wl - (r+\delta)k - f^{pr} + (1+r)a \; - \kappa \; + \chi p(\mathcal{S}),$$
$$k \leq \frac{a}{1-\theta^{pb}}, \quad d \geq 0, \quad \chi p(\mathcal{S}) = \frac{\chi}{1-\chi}\mathbb{E}[M(z,z')V^{pb}(\mathcal{S}')|\mathcal{S}]$$

**Exit**: $V^{x,pr}(\mathcal{S}) = \pi(\mathcal{S}) + (1+r)a$

# Value function: Entrants

- **There is a large number of potential entrants each period**
  - → If they enter, they become **private firms**
  - → Endowed with initial net worth $a_0$
  - → Draw initial productivity $s_0$ from a log normal distribution
- **Potential entrants solve**

$$V^e(\mathcal{S}_0) = \max_{a'} -a' + \mathbb{E}[M(z, z')V^{pr}(\mathcal{S}')|\mathcal{S}_0]$$

  - → Given $\mathcal{S}_0 = (s_0, z, a_0)$, choose to enter if $V^e(\mathcal{S}_0) \geq c_e$ .

# Quantitative Analysis

# Calibration

- **U.S. non-financial firm sector, 2000Q1-2019Q4** (quarterly)

  → Public ∼ Compustat, Private ∼ BDS & Flow of Funds, IPO cost ∼ Compustat + BDS

## Externally calibrated

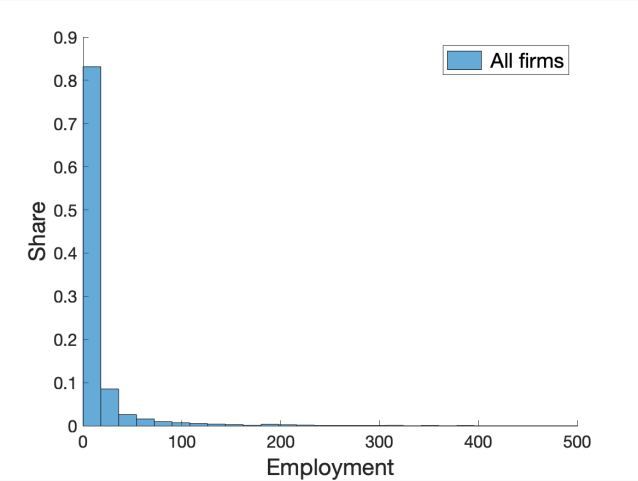
| | Meaning | Value |
|---|---|---|
| $\eta$ | Returns to scale | 0.88 |
| $\alpha$ | Capital share | 0.30 |
| $\delta$ | Depreciation rate | 0.03 |
| $\rho_z$ | Persistence aggregate shock | 0.95 |
| $\sigma_z$ | SD aggregate shock | 0.007 |
| $\chi$ | Equity share sold at IPO | 0.10 |
| $\beta$ | Time discount | 0.97 |
| $\phi_0$ | Stochastic discount factor | 28.59 |
| $\phi_1$ | Stochastic discount factor | -30.90 |

## Internally calibrated

| | Meaning | Value | Target | Data | Model |
|---|---|---|---|---|---|
| $\rho_s$ | Persistence idio. shock | 0.93 | AC of log sales | 0.63 | 0.41 |
| $\sigma_s$ | SD idiosyncratic shock | 0.07 | SD of log sales | 0.35 | 0.35 |
| $\theta^{pb}$ | Borrowing constraint | 0.55 | Debt-to-assets | 0.77 | 0.77 |
| $\theta^{pr}$ | Borrowing constraint | 0.35 | Debt-to-assets | 0.42 | 0.40 |
| $f^{pb}$ | Operating cost | 5.2 | Exit rate | 0.02 | 0.03 |
| $f^{pr}$ | Operating cost | 1.5 | Exit rate | 0.09 | 0.08 |
| $\kappa$ | IPO fixed cost | 170 | Emp. share of public | 0.33 | 0.35 |

⇒ **Costs and benefits of IPO**

# Model performance: Size distribution




- **Most firms are small**

  ... consistent with the data

| Size | 1-9 | 10-19 | 20-99 | 100+ |
|---|---|---|---|---|
| **Data** | 0.77 | 0.12 | 0.10 | 0.02 |
| **Model** | 0.61 | 0.24 | 0.12 | 0.03 |

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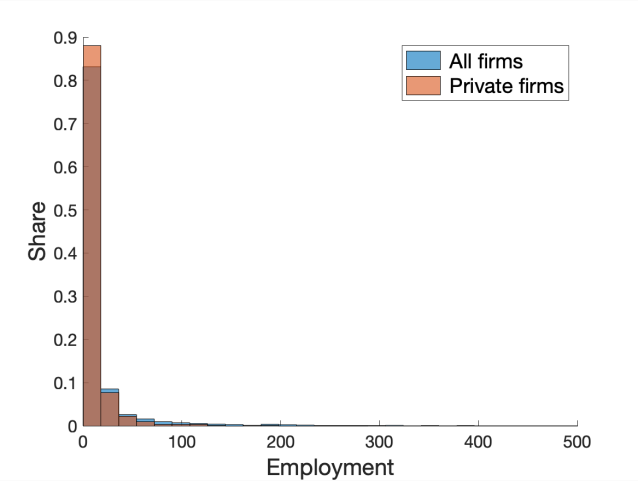


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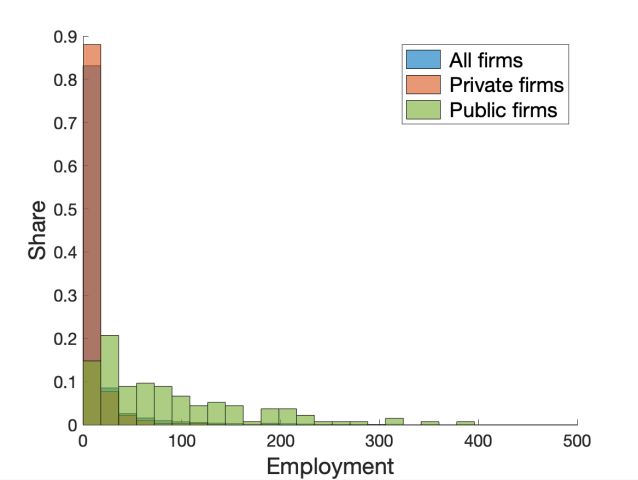


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- **Public firms are larger**

| Size | 1-9 | 10-19 | 20-99 | 100+ |
|---|---|---|---|---|
| Private | 0.65 | 0.25 | 0.10 | 0.01 |
| Public | 0.04 | 0.13 | 0.50 | 0.32 |
| Data | 0.04 | 0.03 | 0.17 | 0.76 |

# Model performance: IPO dynamics

- **Firm-level IPO effect** (Untargeted)
  - → On one-year employment growth
    - ... Data: 0.37 (Borisov et al., 2021)
    - ... Model: 0.42

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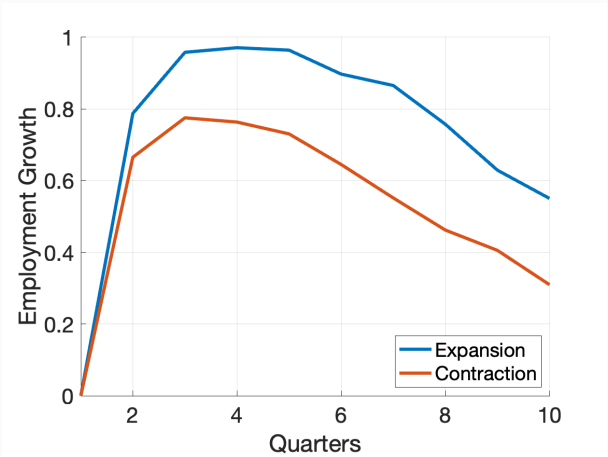

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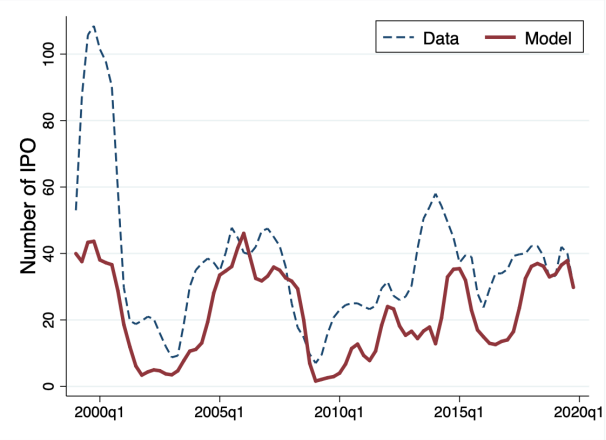
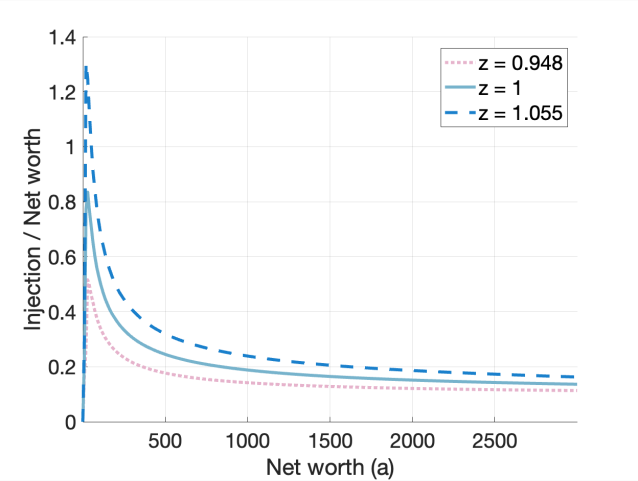
- **Procyclical number of IPOs**



# Capital Injection Cyclicality




- **Capital injection at IPO** ◂ by prod.
  for the most productive firm
  → **Procyclical!**

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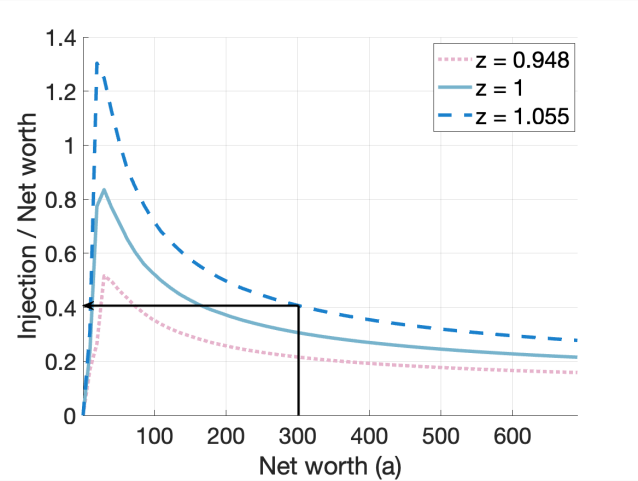


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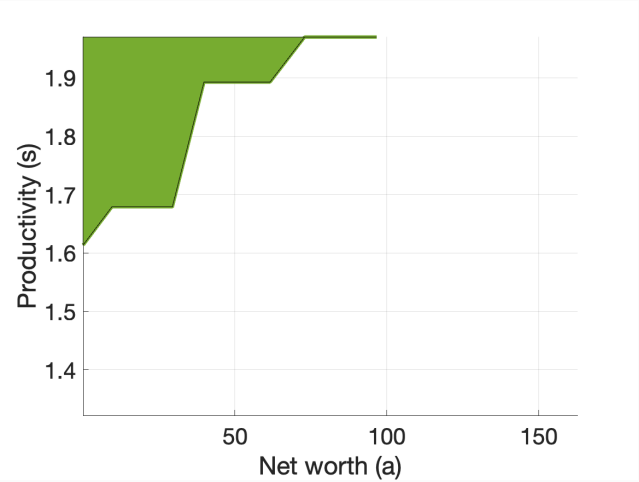
**Example**

For a firm with $a = 300$,
an IPO would increase $a$ by ...
→ 40% during booms

# IPO decision

**IPO Threshold** (Firms above the threshold go public)




- **Stationary**

  → **Selection at IPO**

  Small & productive firms

  (most financially constrained)

◂ Original

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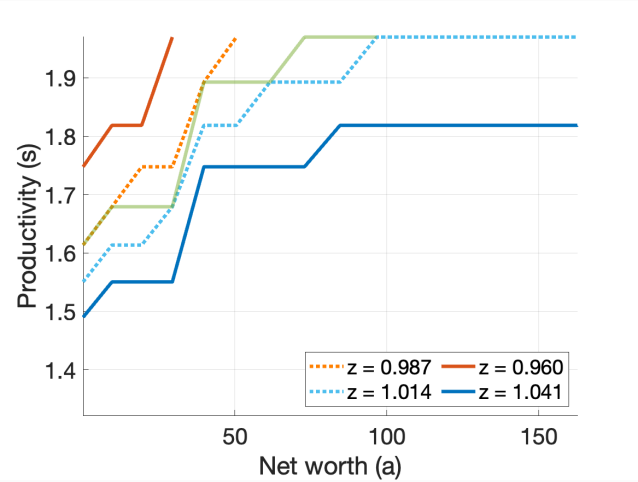


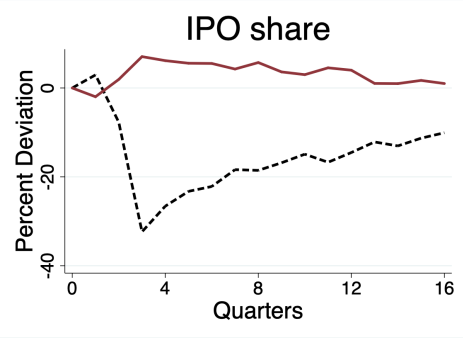

- **Stationary**
  - → **Selection at IPO**
    Small & productive firms
    (most financially constrained)
- **Non-stationary**
  - → In a **recession**, IPO firms are
    - ... fewer in number
    - ... smaller in size
    - ... more productive
  - ⇒ **IPO cyclicality!**

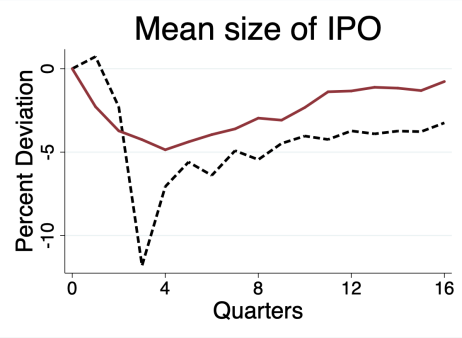
◂ Original

# Counterfactual analysis

## How does IPO cyclicality affect aggregate employment dynamics?

- Simulate recovery process from $-1\%$ shock on aggregate productivity
- **Shut down cyclicality of IPOs** (Assign stationary IPO policy function)



# Results and mechanisms

- Without IPO cyclicality, **employment decreases less**
  - → IPO cyclicality **exacerbates capital misalloction**

| | Baseline | Counterfactual | Dev. (%) |
|---|---|---|---|
| Employment | -6.44 | -5.77 | 10.40 |
| Mean size of firms | -4.05 | -3.68 | 9.14 |
| Public firm share | -2.39 | 1.12 | 146.86 |
| Number of firms | -2.35 | -1.99 | 15.32 |
| Entry rate | -6.57 | -5.44 | 17.20 |

**Without IPO cyclicality,**

→ IPO firms ⇑

→ Post-IPO (public) firms allocate resources more efficiently

→ **They grow fast, increasing mean size of firms**

# Results and mechanisms

- Without IPO cyclicality, **employment decreases less**
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  - → IPO cyclicality **discourages firm entries**

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**Without IPO cyclicality,**

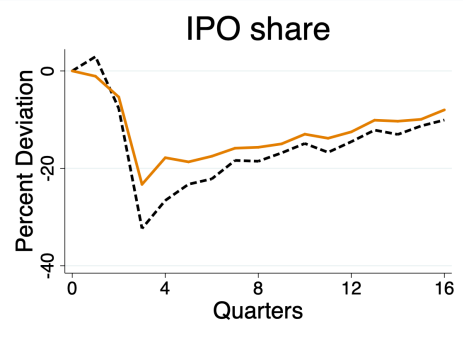
→ Chance to raise funds for private firms ⇑

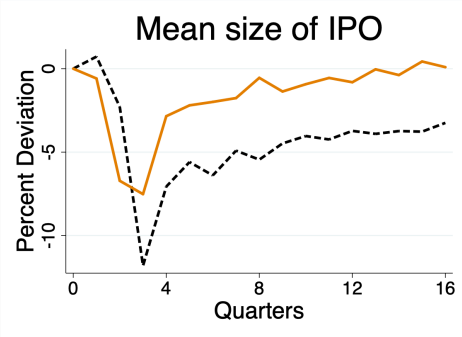
→ Expected future value of entry ⇑

→ **More entries, increasing the number of firms**

# Counterfactual analysis II

- **Shut down cyclicality of capital injection** (Assign constant price $p(a, s)$)
  - → Constant discount factor → Firms and investors **expect faster recovery**
  - → Share of IPO decreases by at most 30%



# Results

- Without capital injection cyclicality, **employment decreases less by 1.4%**
  - → **Extensive margin** is the main driver, rather than **intensive margin**
    - Capital injection at IPO has a **short-term effect**

| | Baseline | Counterfactual II | Dev. (%) |
|---|---|---|---|
| Employment | -6.44 | -6.35 | 1.40 |
| **Mean size of firms** | -4.05 | -4.03 | **0.49** |
| Public firm share | -2.39 | -2.10 | 10.64 |
| **Number of firms** | -2.35 | -1.14 | **52.30** |
| Entry rate | -6.57 | -5.94 | 9.59 |

# Results

- Without capital injection cyclicality, **employment decreases less by 1.4%**
  - → **Extensive margin** is the main driver, rather than **intensive margin**
    - Capital injection at IPO has a **short-term effect**
    - Expected future value of entry responds to the **long-term stability in financing**

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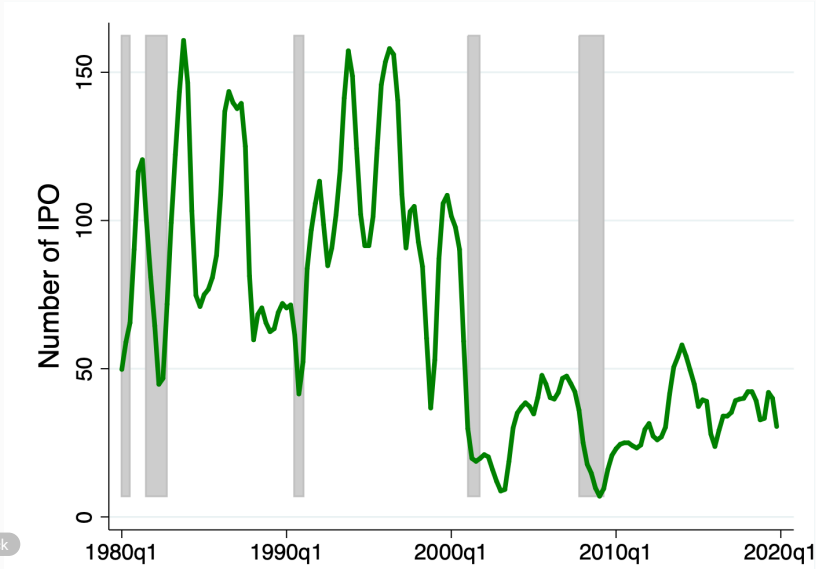
# Conclusions

- **I analyze IPO cyclicality**
  - → In recessions, IPO firms are fewer, smaller, raise less capital, and grow slower
- **I develop a quantitative model and calibrate to the U.S. economy**
- **I quantify the role of IPO cyclicality on aggregate employment during recessions**
  - → It amplifies aggregate employment volatility by **10 percent**!
  - → Fewer IPOs during recessions
    - mean size of firms decreases by **9 percent** (capital misallocation)
    - number of firms decreases by **15 percent** (business dynamism)
  - → Here, cyclicality of capital injection plays a role by **1.4 percent**
- **Promoting more IPOs during recessions could accelerate economic recovery!**

# Procyclical Number of IPOs




Source: *Compustat*

# Sample Selection

- **Exclude ...**
  - → Utilities, financial firms, and public administration
  - → Headquartered outside the U.S.
  - → Underwent leveraged buyouts and subsidiaries

- **Focus on IPO firms seeking financing**
  - → Firms typically conduct IPOs to **raise funds** or **establish public valuation**
  - → Exclude firms delisted shortly after going public for the following reasons:
    - *Acquisition or merger* (11.8%)
    - *Reverse acquisition* (1.3%)
    - *Leveraged buyout* (0.5%)

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# Industry Composition - Service

| | Expansion | Contraction |
|---|---|---|
| **Service** | | |
| Wholesale Trade | 0.04 | 0.04 |
| Retail Trade | 0.06 | 0.03 |
| Transportation and Warehousing | 0.02 | 0.02 |
| Information | 0.17 | 0.13 |
| Real Estate | 0.01 | 0.01 |
| Professional, Scientific, and Technical | 0.06 | 0.06 |
| Management | 0.02 | 0.02 |
| Administrative | 0.01 | 0.01 |
| Educational | 0.03 | 0.04 |
| Health | 0.01 | 0.01 |
| Arts and Entertainment | 0.03 | 0.03 |
| Accommodation | 0.01 | 0.00 |

- **Mostly no difference**
  - → including *Professional, Scientific, and Technical*
- **Expansion** cohort's 5 pp higher share of service comes from ...
  - → *Retail Trade* (6% vs. 3%)
  - → *Information* (17% vs. 13%)

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# Capital Injection Cyclicality

| Log **sale of stock** at IPO | (1) | (2) | (3) |
|---|---|---|---|
| IPO in Contraction | -0.378* | | |
| | (-2.22) | | |
| Detrended Log GDP | | 0.295*** | 0.195*** |
| | | (13.87) | (7.50) |
| Detrended PE Ratio | | | 0.062*** |
| | | | (6.67) |
| Firm Characteristics at IPO | ✓ | ✓ | ✓ |
| Industry FE | ✓ | ✓ | ✓ |
| State FE | ✓ | ✓ | ✓ |
| Observations | 5,096 | 5,096 | 5,096 |
| $R^2$ | 0.297 | 0.322 | 0.328 |

- **IPO Firms in Contraction**
  - → Raise 38% less capital compared to those in **Expansion**.
- **Detrended Log GDP**
  - → 1% increase in GDP $\Rightarrow$ 30% increase
  - → When controlling for stock market performance, ... $\Rightarrow$ 20% increase

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# Non-parametric Regression

$$\Delta^{ipo} N_{it} = \beta_{a,c} Age_{it} \times Cohort_i^{ipo} + \Phi Y_t + \Gamma \mathbf{X_i} + \epsilon_{it}$$

- $\Delta^{ipo} N_{it}$: employment growth (log difference) from the year of IPO
- $Age_{it}$: a dummy for the number of years since IPO
  $Cohort^{ipo}$: a dummy indicating the IPO cohort (Contraction, Expansion)

  → $\beta_{a,c}$ refers to the cohort $c$'s cumulative employment growth in the $a$ th year post-IPO
- $Y_t$: current detrended log real GDP
  $\mathbf{X_i}$: characteristics at IPO (employment, sales per worker, capital intensity, debt-to-assets ratio), industry FE, and state FE

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# Exit Rates by IPO Cohort

| Delisting rate | Expansion | Contraction |
|---|---|---|
| **in 5 years** | 0.34 | 0.34 |
| Merger and acquisition | 0.11 | 0.08 |
| Exit (Bankruptcy or unknown) | 0.16 | 0.22 |
| Back to private | 0.06 | 0.02 |
| **in 3 years** | 0.18 | 0.19 |
| Merger and acquisition | 0.02 | 0.01 |
| Exit (Bankruptcy or unknown) | 0.11 | 0.16 |
| Back to private | 0.03 | 0.00 |
| **in a year** | 0.05 | 0.06 |
| Exit (Bankruptcy or unknown) | 0.04 | 0.05 |
| Back to private | 0.01 | 0.00 |

- **Delisting rates are similar**
  - → **Contraction cohort**
    Higher likelihood of exiting the market
  - → **Expansion cohort**
    More likely to delist due to mergers or reverting to private ownership

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# Aggregate fluctuation

- **Stochastic discount factor** (Clementi and Palazzo, 2019)

$$M(z_t, z_{t+1}) \equiv \beta \exp(\phi_0 \log(z_t) + \phi_1 \log(z_{t+1}))$$

→ $\phi_0 > 0, \quad \phi_1 < 0$ ... **procyclical**

- **Interest rate**

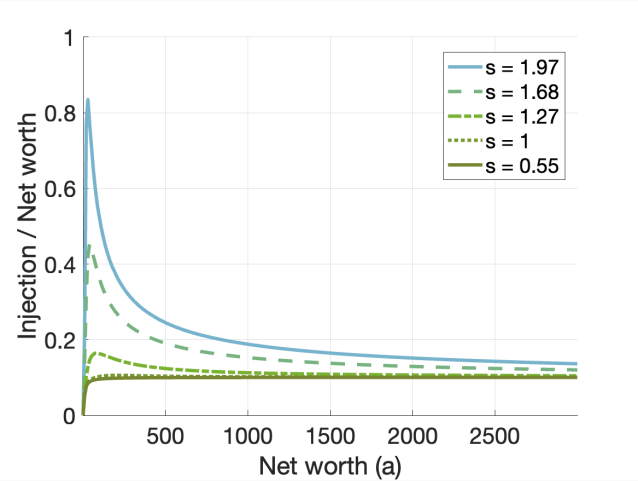
→ Defined as the inverse of the expected stochastic discount factor

$$r(z_t) = \frac{1}{\beta} \exp\left(-z_t(\phi_0 + \rho_z \phi_1) - \frac{\phi_1^2 \sigma_z^2}{2}\right) - 1$$

→ $\phi_0 + \rho_z \phi_1 > 0$ ... **countercyclical**

Back to r Back to M

# Capital injection at IPO




- **Asymmetric increase**
  over firm-specific productivity
  → **Large variance in small firms**

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# IPO threshold