External Financing and the Role of Financial Frictions over the Business Cycle: Measurement and Theory

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Introduction

- Question: How important are financial shocks over the business cycle?

- Conventional View: financial shocks limit firms’ ability to borrow to finance investment

- This Paper:
  - Use data on financial flows to quantitatively evaluate the importance of this view
  - Find financial shocks play sizable role, but face challenges accounting for particularly large recessions
Role of External Funds

- What firms use external funds in the data?

- Not aggregate of nonfinancial firms
  - Funds flow from nonfinancial firms to rest of economy essentially all the time

- Possibility:
  - Some firms use external funds to finance part of investment
  - Other firms generate external funds above own investment needs
External Funds and Heterogeneity

- Finding: Two kinds of heterogeneity in financial flows

- Among publicly held firms (as a fraction of aggregate investment):
  - Total inflows to firms receiving inflows: 22%
  - Total outflows by firms making outflows: 50%

- Among privately held firms (as a fraction of aggregate investment):
  - Total inflows to firms receiving inflows: 82%
  - Total outflows by firms making outflows: 170%

- Suggests reallocation important
This Paper

- Develop quantitative model of financial frictions with heterogeneous firms and idiosyncratic risk
- Model financial frictions as collateral constraints
- Model financial shocks as shocks to collateral constraints
- Use data on financial flows to discipline importance of role of financial markets
Quantitative Results

• Analyze unanticipated shock to collateral constraint in calibrated model
  ◦ Shock calibrated to generate 1 St. Dev. decline in debt-to-assets on impact
  ◦ Half-life of shock is 1 year

• Findings:
  ◦ Output falls by 0.4% on impact
  ◦ Effect on output roughly 2.5 times as persistent as shock
  ◦ Consumption, Investment, Employment move in same direction of output
  ◦ Sectors of economy move together
Related Literature

- **Financial frictions and Business Cycles:**
  - Carlstrom-Fuerst (1993), Kiyotaki-Moore (1997, 2008), and many others
  - Jermann-Quadrini (2012), Khan-Thomas (2014),
    Basetto-Cagetti-DeNardi (2011)

- **Modeling financial frictions:**
    Moll(2014)

- **Measuring External Funds:**

- **Trade Linkages:**
Plan of the Talk

- Stylized Facts on Financial Flows
- Dynamic Model of Financial Frictions
- Calibration Results
Evidence on Financial Flows and External Financing
Measuring Financial Flows

- Budget constraint

\[ d_{it} + k_{it+1} - (1 - \delta)k_{it} \leq p_{it}q_{it} - w_{tlit} - r_{tb_{it}} + b_{it+1} - b_{it} \]

- Re-arranging

\[ \left( \frac{k_{it+1} - (1 - \delta)k_{it}}{X_{it}} \right) - \left( \frac{p_{it}q_{it} - w_{tlit} - r_{tb_{it}}}{AF_{it}} \right) \leq b_{it+1} - b_{it} - d_{it} \]

- \( X_{it} - AF_{it} \): Inflow of External Funds

- Use same conceptual measure in aggregate and disaggregated data

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Aggregate Financial Flows

- U.S. Flow of Funds, 1952-2010
  - $AF_t = \text{After Tax Profits} + \text{Depreciation}$
  - $X_t = \text{Capital Expenditures}$

- Available Funds: average 18% of Non-Financial Corporate GDP

- Investment: average 15% of Non-Financial Corporate GDP
Aggregate Financial Flows

- U.S. Flow of Funds, 1952-2010

- Firms can internally finance investment *all the time*

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Firm-Level Financial Flows

- Firm level data sources
  - Privately held: Amadeus – U.K., 2005-2012

- Comparison of Public and private firms in U.K.

<table>
<thead>
<tr>
<th>Company Type</th>
<th>Assets</th>
<th>Investment</th>
<th>Sales</th>
<th>I/A</th>
<th>AF/A</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cross-Sectional Median (Millions or %)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private</td>
<td>0.24</td>
<td>0.002</td>
<td>0.38</td>
<td>1.23%</td>
<td>14.99%</td>
</tr>
<tr>
<td>Public</td>
<td>115.86</td>
<td>2.66</td>
<td>126.71</td>
<td>3.07%</td>
<td>10.42%</td>
</tr>
</tbody>
</table>

Firm Year Observations: Private ≈ 700,000; Public ≈ 10,000

- Private firms much smaller
- Private firms comparable investment, profitability

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Firm-Level Net Financial Inflows

- In Compustat

\[ AF_{it} = \text{Operating Activities Net Cash Flow} \]
\[ X_{it} = \text{Capital Exp. } + \text{Acquisitions } - \text{Sale of PPE} \]

- In Amadeus

\[ AF_{it} = \text{Income Before Ext. Items } + \text{Depreciation} \]
\[ X_{it} = \Delta \text{ Fixed Assets } _t + \text{Depreciation} \]

- Note, \( X_{it} \) not just purchases of new capital goods

- \( X_{it} \) has reallocation dimension

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Construct measure of inflows:

\[
\text{Inflows} = \frac{1}{T} \sum_{t=1}^{T} \frac{\sum_i (X_{it} - AF_{it}) 1[X_{it} \geq AF_{it}]}{\sum_i X_{it}}
\]

- Public firms, Inflows roughly 20%
- Private firms, Inflows roughly 80%
Private firms use more external funds than public firms

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Comparing Public and Private Firms

- Private firms on average smaller
- Private firms more concentrated in services industry
- Is public/private difference only capturing size/industry composition? No.
- Compare use of external funds within industry/size class
  - Focus only on U.K. firms
### Within Industry Heterogeneity

<table>
<thead>
<tr>
<th>Industry</th>
<th>Investment Share</th>
<th>Use of Ext. Fin.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Private</td>
<td>Public</td>
</tr>
<tr>
<td>Agriculture</td>
<td>0.58%</td>
<td>0.05%</td>
</tr>
<tr>
<td>Construction</td>
<td>-1.32%</td>
<td>0.17%</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>19.53%</td>
<td>34.71%</td>
</tr>
<tr>
<td>Mining</td>
<td>17.68%</td>
<td>2.21%</td>
</tr>
<tr>
<td>Retail Trade</td>
<td>10.31%</td>
<td>18.74%</td>
</tr>
<tr>
<td>Services</td>
<td>30.64%</td>
<td>8.85%</td>
</tr>
<tr>
<td>Transportation</td>
<td>17.39%</td>
<td>35.19%</td>
</tr>
<tr>
<td>Wholesale Trade</td>
<td>5.20%</td>
<td>1.03%</td>
</tr>
</tbody>
</table>

- Within each broad industry, private firms use more external funds
- Relationships stable over time

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Within Size Class Heterogeneity

- Define asset quartiles for public firms in each year
- Use public thresholds to bin private firms

<table>
<thead>
<tr>
<th>Quartile</th>
<th>Investment Share</th>
<th>External Financing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Private</td>
<td>Public</td>
</tr>
<tr>
<td>Q1</td>
<td>6.03%</td>
<td>0.18%</td>
</tr>
<tr>
<td>Q2</td>
<td>9.83%</td>
<td>1.27%</td>
</tr>
<tr>
<td>Q3</td>
<td>21.55%</td>
<td>5.25%</td>
</tr>
<tr>
<td>Q4</td>
<td>62.59%</td>
<td>93.34%</td>
</tr>
</tbody>
</table>

- Private firms use more external funds than similarly sized public firms
- Similar with deciles, stable over time

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External Financing and Financial Frictions
A Dynamic Model of Financial Frictions
Model Ingredients

- Central Ingredient
  - Heterogeneous firms with idiosyncratic risk

- Other ingredients
  - Two types of firms: publicly & privately held
  - Trade Linkages:
    - Differentiated goods, monopolistic competition
    - Input-output structure in production
Environment

- Dynamic economy, \( t = 0, 1, 2, \ldots \)

- Agents:
  - Representative Worker (owns publicly held firms)
  - Owners of privately held firms

- Firms: continuum, measure 1 of intermediate good producers
  - \( i \in [0, s] \) are \textit{privately held}
  - \( i \in (s, 1] \) are \textit{publicly held}
Intermediate Good Production

- In period $t$, firm $i$ uses capital, labor and intermediate input to produce gross output

$$q_{it} = z_{it} \left( k_{it}^{\alpha} l_{it}^{1-\alpha} \right)^{\eta} I_{it}^{1-\eta}$$

- Idiosyncratic productivity shock:

$$\ln z_{it} = \rho_z \ln z_{it-1} + \sigma_z \epsilon, \epsilon \sim N(0, 1)$$

- Firms *exogenously* exit at rate $\zeta$

- New firms draw from current distribution of wealth and tfp

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Final Good Production and Market Clearing

- Final Good produced competitively according to

\[ Q_t = \left[ \int_0^1 q_{it} \left( \frac{1 - \frac{1}{\rho}}{\rho - 1} \right) \right]^{\rho} \]

- Aggregate goods market clearing

\[ C_t^W + \int_0^s d_{it} di + K_{t+1} - (1 - \delta)K_t = Q_t - \int_0^1 I_{it} di \]
Preferences

- Owners of Privately Held Firms:
  \[ E \sum_t (\beta(1 - \zeta))^t \ln d_{it} \]

- Representative Worker
  \[ \sum_t \beta^t \ln \left( C_t - \frac{\psi}{1 + \frac{1}{\epsilon}} L_t^{1 + \frac{1}{\epsilon}} \right) \]
  ○ SDF: \( M_t \)
Producer’s Problem

- Maximize utility of owners subject to

- Budget Constraint:

\[ d_{it} + a_{it+1} \leq\]

\[ p_{it}z_{it} \left( k_{it}^{\alpha} l_{it}^{1-\alpha} \right)^\eta I_{it}^{1-\eta} - w_{it} l_{it} - I_{it} - (r_{t} + \delta)k_{it} + (1 + r_{t})a_{it} \]

- Collateral Constraint (\( \lambda \geq 1 \)):

\[ k_{it} \leq \lambda a_{it} \]

- Inverse demand function for monopolistically competitive output
Worker’s Problem

- Workers own publicly held firms

- Workers maximize discounted lifetime utility

\[ \sum_t \beta^t \ln \left( C_t - \frac{\psi}{1 + \frac{1}{\epsilon}} L_t^{1 + \frac{1}{\epsilon}} \right) \]

- Subject to sequence of budget constraints

\[ C_t^W + A_{t+1}^W \leq w_t L_t + (1 + r_t) A_t^W + \int_s^1 d_{it} di \]

- Implies objective of publicly held firm:

\[ E \sum_t M_t d_{it} \]
• Market Clearing:

\[ K_t \equiv \int_0^1 k_{it} \, di = A_W^t + \int_0^1 a_{it} \, di \]

\[ L_t = \int_0^1 l_{it} \, di \]

\[ C_W^t + \int_0^s d_{it} \, di + K_{t+1} - (1 - \delta)K_t = Q_t - \int_0^1 I_{it} \, di \]
Equilibrium Definition (Recursive)

- A stationary equilibrium consists of
  - \((d_L(a, z), a'_L(a, z), k'_L(a, z), l_L(a, z), I_L(a, z))\)
  - \((d_U(a, z), a'_U(a, z), k'_U(a, z), l_U(a, z), I_U(a, z))\)
  - \(C^W, L, A^w\)
  - \(G_U(a, z), G_L(a, z)\)

satisfying

- Optimality, market clearing
- \(G_j\) is stationary:

\[
G^*_j = \int_{a,z} H_j((a, z), A \times Z) G^*_j(a, dz)
\]

where

\[
H_j((a, z), A \times Z) = \int_Z \mathbf{1}_{\{a'_j(a, z) \in A\}} \psi(z) dz
\]

with \(j = U, L\).
Discussion on Publicly Held Firms
Proposition

Suppose $z$ is bounded above. Then, in a stationary equilibrium, the collateral constraint does not bind for any publicly held firm.

- If $d_{it} > 0$ then constraint does not bind along any future outcome path
- $\exists \bar{a}$ such that for $a > \bar{a}$ the firm is unconstrained for all future histories
- As long as constraint binds with positive probability, $a' > a + \epsilon$ for some small $\epsilon > 0$

- Implies publicly held firms do not require much external funds for investment, as in data

Shourideh & Zetlin-Jones, External Financing and Financial Frictions
Calibration and Results
Calibration Overview

- Model period is 1 year

- Critical parameters for calibration:
  - Process for idiosyncratic risk \((\rho_z, \sigma_z)\)
  - Collateral constraint \((\lambda)\)

- All else equal, these parameters determine “bindingness” of the collateral constraint

- Use financial data (use of external funds, dispersion in leverage, aggregate indebtedness) to discipline model parameters

- Remaining parameters standard or perform sensitivity
## Calibrated Parameters and Moments

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Moment</th>
<th>Model</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Calibrated Parameters</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collateral Constraint ($\lambda$)</td>
<td>6.98</td>
<td>External Financing</td>
<td>0.82</td>
<td>0.82</td>
</tr>
<tr>
<td>Persistence of Idio. TFP ($\rho_z$)</td>
<td>0.95</td>
<td>Debt-to-Total Assets</td>
<td>0.49</td>
<td>0.49</td>
</tr>
<tr>
<td>Std. of Idio. TFP ($\sigma_z$)</td>
<td>0.33</td>
<td>Dispersion in Net Debt-to-Assets</td>
<td>0.54</td>
<td>0.54</td>
</tr>
<tr>
<td>Disutility of labor ($\psi$)</td>
<td>0.41</td>
<td>Aggregate Hours</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>Share of private firms ($s$)</td>
<td>0.41</td>
<td>Private Firms Share of Gross Output</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Share of Intermediate Inputs ($\eta$)</td>
<td>0.43</td>
<td>Intermediate Input Share</td>
<td>0.43</td>
<td>0.43</td>
</tr>
<tr>
<td><strong>Fixed Parameters</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discount Rate ($\beta$)</td>
<td>0.96</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labor Supply Elasticity ($\varepsilon$)</td>
<td>2.6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elasticity of Substitution ($\rho$)</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capital Share ($\alpha$)</td>
<td>0.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depreciation Rate ($\delta$)</td>
<td>0.07</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exit Risk of Private Firms ($\zeta$)</td>
<td>0.10</td>
<td></td>
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</tr>
</tbody>
</table>

- $\lambda$ implies firms can collateralize up to 86% of capital
- 28% of private firms face binding collateral constraint
How Does the Model Do?
Idiosyncratic Risk

• How much idiosyncratic risk do firms face?

• Analyze employment growth in model and data

• Measure cross-sectional dispersion in employment growth
  ○ In Model: \( \approx 0.47 \)
  ○ In Data (for privately held firms): 0.42 (Davis et al. 2007)

• Matching financial flows does not induce “too much” firm level volatility
Main Quantitative Experiment:
Effect of Shocks to \( \lambda \)
Impulse Response Exercise

- Feed in Impulse to $\lambda$ to get 1 S.D. shock to aggregate Debt-to-Assets (Half-life = 1 Year)
Impulse Response Exercise

- GDP falls 0.4%, half-life roughly 2.5 years

Comparative in size to TFP shock, endogenous persistence

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• Constrained firms cannot rent as much capital as without shock
  ◦ firms with positive TFP shocks now or recently

• Unconstrained firms rent more capital than without the shock
  ◦ firms with negative TFP shocks now or recently
  ◦ publicly held firms

• Implies capital not reallocated to “right” firms
Explaining the Fall in Output

- Misallocation implies loss in average measured tfp

![Graph showing measured productivity deviation from steady state over periods.](image)
- Co-movement in aggregate outcomes
- Fall in investment and mis-allocation imply persistent effects

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Response of Public and Private Firms

- Sales diverge on impact, both correlated after 1 year
The Effects of Trade Linkages

- Differentiated Goods, monopolistic competition, input-output

- Consider effect of adverse financial shock on unconstrained firms:
  - Reduces labor, capital, and intermediate input demand of constrained firms

  ⇒ wage and capital rental rate fall, tending to raise output of unconstrained firms

  ⇒ Monopolistic competition + input-output structure implies demand for goods produced by unconstrained firms fall

- Elasticity of substitution & labor supply important determinants
Share of Output by Publicly Held Firms

- Share of Output rises then returns to 0
Compustat Share of Gross Output

- Implications for how Publicly held and privately held are affected by financial shocks

- How do these firms vary over the cycle?

- Construct gross output of non-financial publicly held firms as aggregate of Compustat

- Analyze Compustat share of Total non-financial gross output in U.S.
Compustat Share of Gross Output

- Percentage Deviations from a linear trend
Effects of Shocks toAggregate TFP
Impulse Response Exercise

- Path for measured TFP (with and without Collateral Constraint)

![Graph showing measured productivity with and without constraints, and benchmark collateral shock]
Impulse Response Exercise

- GDP with and without constraint falls by .9%
Implications for Financial Flows

- Shock has opposite effect on external funds from financial shock

![Use of External Funds](image-url)

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Implications for Financial Flows

- Decline in external funds since crisis period, especially among private firms
Sensitivity Analysis
Sensitivity Analysis

- **Larger Shocks:**
  - If financial shock generates 2008 decline in commercial lending, GDP falls by 2%

- **Exit Risk of Private Firms:**
  - If $\zeta = 0.05$ (not 0.10), financial shock induces 0.1% decline in GDP
  - Re-calibrating implies larger effect
Sensitivity Analysis

- **Trade Linkages (elasticity of substitution):**
  - If $\rho = 10$, financial shock induces 0.4% decline in GDP
  - No co-movement between public and private firms

- **Share of Private Firms:**
  - Only private firms, financial shock induces 4.5% decline in GDP
  - Highlights importance of understanding response of unconstrained firms

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Conclusion

- Evaluated importance of financial markets in channeling funds to firms with profitable investment opportunities.
- Documented heterogeneity in firms’ use of external funds.
- Developed quantitative model of financial frictions consistent with observed firm heterogeneity.
- Found financial shocks have sizable effects.
- Found financial shocks face challenges in accounting for particularly large recessions when confronted with patterns of external financing.