The Behavior of Small and Large Firms over the Business Cycle

V.V. Chari, Larry Christiano, Patrick Kehoe
Credit market frictions central in propagating the cycle

Theory
- Kiyotaki-Moore, Bernanke-Gertler, Cooley-Marimon-Quadrini and dozens more

Evidence:
- small firms more sensitive to cycle: Gertler-Gilchrist, Sharpe
- balance sheet effects: Fazzari, Hubbard, Peterson
- inventories: Kashyap, Lamont and Stein
"Long standing tradition in macroeconomics beginning with Fisher and Keynes that gives a central role to credit markets conditions in the propagation of aggregate fluctuations” (Bernanke, Gertler and Gilchrist, 1999)

"Although the underlying theories [of credit market frictions] are diverse, a common prediction is that differences in cyclical behavior should emerge across firms depending on their respective access to capital markets” (Gertler, Gilchrist, 1994)

Kockerlakota’s (2000) survey of theory: Credit constraints are mechanisms for turning small shocks into large, persistent movements in aggregate income
Our Question

Do small firms decline more than large ones in downturns?

Idea: small firms have less access to capital markets than large firms
Outline

- Postwar Data
  - Manufacturing (QFR)
    - Start with Gertler-Gilchrist (RR dates)
    - Contrast with Business Cycle dates
  - All Sectors (CBP)
- Great Depression Data
  - Moody’s data on individual firms
  - Census data
- Theory
  - help interpret results
Most Influential Evidence: Gertler-Gilchrist

- QFR data on sales, loans, inventories by asset size
- Size is a good measure of financial markets access
- Small firms hurt more by monetary contractions (RR dates)
  - small firms sales and inventories fall more than large
  - small firms debt rises less than large
Quarterly Financial Reports for Manufacturing Corp

- **Data**
  - sales, inventories, loans by eight size classes of nominal assets

- **Advantages**
  - Quarterly, long (1958-2006)
  - All firms in manufacturing

- **Limitations**
  - Repeated cross-section
  - Use size as proxy for access to financial markets
### Sales, Inventories, and Loans by Asset Size, 1986:4

<table>
<thead>
<tr>
<th>Asset size</th>
<th>&lt;5m</th>
<th>5m</th>
<th>10m</th>
<th>25m</th>
<th>50m</th>
<th>100m</th>
<th>250m</th>
<th>1000m</th>
<th>1000m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>57,319</td>
<td>20,821</td>
<td>30,149</td>
<td>22,785</td>
<td>21,412</td>
<td>34,504</td>
<td>67,175</td>
<td>310,291</td>
<td></td>
</tr>
<tr>
<td>Inv</td>
<td>23,377</td>
<td>10,900</td>
<td>17,374</td>
<td>13,221</td>
<td>12,919</td>
<td>21,042</td>
<td>39,164</td>
<td>172,748</td>
<td></td>
</tr>
<tr>
<td>Loans</td>
<td>7,232</td>
<td>3,572</td>
<td>4,878</td>
<td>3,679</td>
<td>3,172</td>
<td>3,857</td>
<td>8,072</td>
<td>41,319</td>
<td></td>
</tr>
</tbody>
</table>
Definition of small firms

- rank firms by asset size from smallest to largest
- cumulate sales of ranked firms till hit 30% of total sales
- large firms are the rest
Percent of Manufacturing Sales by Cumulative Asset Size

<table>
<thead>
<tr>
<th>Year</th>
<th>$5m</th>
<th>$10m</th>
<th>$25m</th>
<th>$50m</th>
<th>$100m</th>
<th>$250m</th>
<th>$1b</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960</td>
<td>0.26</td>
<td>0.31</td>
<td>0.38</td>
<td>0.44</td>
<td>0.52</td>
<td>0.65</td>
<td>0.85</td>
</tr>
<tr>
<td>1970</td>
<td>0.21</td>
<td>0.24</td>
<td>0.29</td>
<td>0.34</td>
<td>0.39</td>
<td>0.49</td>
<td>0.70</td>
</tr>
<tr>
<td>1980</td>
<td>0.13</td>
<td>0.16</td>
<td>0.21</td>
<td>0.24</td>
<td>0.28</td>
<td>0.34</td>
<td>0.47</td>
</tr>
<tr>
<td>1990</td>
<td>0.12</td>
<td>0.15</td>
<td>0.19</td>
<td>0.22</td>
<td>0.26</td>
<td>0.32</td>
<td>0.44</td>
</tr>
<tr>
<td>2000</td>
<td>0.06</td>
<td>0.09</td>
<td>0.12</td>
<td>0.15</td>
<td>0.18</td>
<td>0.22</td>
<td>0.32</td>
</tr>
</tbody>
</table>

- 38% of 1960 sales by firms with assets ≤ 25m
Most Influential Evidence: Gertler-Gilchrist

- QFR data on sales, loans, inventories by asset size
- Size is a good measure of financial markets access
<table>
<thead>
<tr>
<th>Type of debt as percentage of total</th>
<th>Asset size (in millions of dollars)</th>
<th>Percentage of bank loans</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All</td>
<td>&lt;50</td>
</tr>
<tr>
<td>% of bank loans</td>
<td>0.30</td>
<td>0.68</td>
</tr>
</tbody>
</table>
Small firms rely heavily on bank loans

Consistent with firm level studies

- Studies sort firms by direct access to financial markets "likely to be constrained" firms smaller (Kashyap, Lamont, Stein)

Size controls not capturing industry effects
Durable and nondurables have similar size distribution

### Ratio of Durable/Total Manufacturing Sales 1986:4

<table>
<thead>
<tr>
<th></th>
<th>&lt;25</th>
<th>&lt;50</th>
<th>&lt;250</th>
<th>&lt;1000</th>
<th>All mfg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Durables/total sales</td>
<td>.52</td>
<td>.52</td>
<td>.52</td>
<td>.50</td>
<td>.51</td>
</tr>
</tbody>
</table>
Analysis of QFR data

- Small and Large firms
  - Sales
  - Inventories
  - Loans

- Popular Belief: small firms hurt more in recessions
  - Sales and inventories fall more than large
  - Small able to borrow less than large
Start with Sales

- Overview of data
- Episodic analysis
  - Romer-Romer Dates (6 monetary contractions)
  - Business Cycle Dates (9 NBER peaks)
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std dev (sales small)/ std dev (GDP) = 2.1
std dev (sales large)/ std dev (GDP) = 2.6
Overview of data

Episodic analysis

- Romer-Romer Dates (6 monetary contractions)
Sales around RR peaks - mean across 6 cycles

-30  -25  -20  -15  -10  -5  0  5  10

Percent deviation from RR peak

Quarters after RR peak

small firms
large firms

RR peak

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The Behavior of Small and Large Firms over the Business Cycle
Start with Sales

- Overview of data
- Episodic analysis
  - Romer-Romer Dates (6 monetary contractions)
  - Business Cycle Dates (9 NBER peaks)
Small firms’s sales

- **May well** fall more than large after monetary contractions
- **Do not** fall more than large in recessions
Inventories

- Overview of data
- Episodic analysis
  - Romer-Romer Dates
  - Business Cycle Dates
Inventories and GDP

-80%
-60%
-40%
-20%
0%
20% 40%
60%
80%
100%
120%


-80%
-60%
-40%
-20%
0%
20% 40%
60%
80%
100%
120%

Large

GDP

Small

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The Behavior of Small and Large Firms over the Business Cycle
std dev (inv small)/ std dev (GDP) = 1.9
std dev (inv large)/ std dev (GDP) = 2.6
Inventories

- Overview of data

- Episodic analysis
  - Romer-Romer Dates
Inventories around RR peaks - mean across 6 cycles

Percent deviation from RR peak

-30 -25 -20 -15 -10 -5 0 5 10 15

Quarters after RR peak

small firms

large firms

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The Behavior of Small and Large Firms over the Business Cycle
Inventories

- Overview of data
- Episodic analysis
  - Romer-Romer Dates
  - Business Cycle Dates
Inventories around NBER peaks - mean across 9 cycles

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The Behavior of Small and Large Firms over the Business Cycle
Inventories Summary

- Small firms’s inventories
  - May well fall more than large after monetary contractions
  - Do not fall more than large in recessions
Overview of data

Episodic analysis

- Romer-Romer Dates
- Business Cycle Dates
Bank Loans and GDP

-80%
-60%
-40%
-20%
0%
20%
40%
60%
80%
100%
120%
140%


Large

GDP

Small

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The Behavior of Small and Large Firms over the Business Cycle
std dev (loans small)/ std dev (GDP) = 2.6
std dev (loans large)/ std dev (GDP) = 6.6
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The Behavior of Small and Large Firms over the Business Cycle
Small firms’s short term debt

- **May well** expand less than large after monetary contractions
- **Do not** fall more than large in recessions
Limitation of QFR

- QFR is just manufacturing

- Does similar pattern hold for the rest of the economy?

- To answer: use County Business Patterns data
Benefits

- All of economy
- Not just manufacturing

Limitations

- Annual
- Only data is employees and establishments
- Establishments not firm level
Definition of small firms

- Rank establishments by employees from smallest to largest
- Add up establishments till get 30% of all employees
- Large establishments are the rest

Two variables

- Employment in small firms
- Number of establishments of small firms
Number of employees around NBER peaks - mean across 5 cycles
The Behavior of Small and Large Firms over the Business Cycle
Limitations of Both QFR and CBP

- Cannot track individual firms (not panel)
- Postwar recession not that large
- Address these issues

Moody’s Data on individual firms in Great Depression
Analysis of Moody’s Data: Use Panel Features

- Definition of small firms
  - order firms by assets
  - cumulate firms’s sales so that sum of sales is 30%
  - defines small firms in 1929
  - small firms sales in 1933
    - find same firms from 1929
    - plus all 1933 entrants
    - use panel not just repeated cross-section
Sales and Assets by Establishment (in dollars)

<table>
<thead>
<tr>
<th></th>
<th>General Motors Corp.</th>
<th>Champion Hardware Co.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assets in 1929</td>
<td>1,324,889,764</td>
<td>573,526</td>
</tr>
<tr>
<td>Assets in 1933</td>
<td>1,183,674,005</td>
<td>422,855</td>
</tr>
<tr>
<td>Sales in 1929</td>
<td>1,504,404,472</td>
<td>625,494</td>
</tr>
<tr>
<td>Sales in 1933</td>
<td>569,010,542</td>
<td>345,227</td>
</tr>
</tbody>
</table>
Method I: Share of total sales by size

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Method I: Sales by size
(ordered by 29 assets, add across firms so that sum of sales is 30% in 29, find same firms in 33; treat entrants as small)
Issues with Repeated Cross-section (like QFR)

- Potential bias due to bin-jumping

- Small firms sales decline
  - overstated if many small winners \textit{(jump up bin)}
  - understated if many large losers \textit{(jump down bin)}

- Use panel aspect of Moody’s to investigate this bias
Is Bin-Jumping a Big Problem?

- Treat data as repeated cross-section (≈ QFR)
- Apply QFR method (II) to Moody’s data
- Does answer from method II differ from tracking firms (I)?
- Answer: not much
Method II: Only Use Cross Section Information

- Definition of small firms in 1929 same as method I
  - rank firms by 1929 assets
  - cumulate firms’s sales so that sum of sales is 30%

- Definition of small firms in 1933 differs
  - whoever has real assets less than 1929 cutoff

- Large in II could be small ”winners” in I
- Small in II could be large ”losers” in I
Sales in 1933 by size and method

- 2
- 4
- 6 8
- 10
- 12

small (method 1) small (method 2) large (method 1) large (method 2)

Billions

Cross section method:
overstates decline of small, understates decline of large
Sales in 1933 by size and method

Billions

- small (method 1)
- small (method 2)
- small winners
- large losers

- stayers
- entrants

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Summary of Bin-Jumping Investigation

- Small firms decline overstated with cross-section
- Large firms decline understated with cross-section
- Suggests our earlier results robust to bin-jumping
Summary

Variety of data sources and time periods

- **Is** evidence that small firms hurt more than large by monetary contractions
- **No** evidence that small firms hurt more than large in recessions

Contribution

Show popular belief is a myth

Where to go from here?
How to interpret these results?

- Option 1: Dismiss evidence from Romer-Romer dates
  - no objective criterion for choice of dates
  - therefore, stop working on financial friction models

- Option 2: Accept evidence from Romer-Romer dates
  - Find financial friction model consistent with both business cycle evidence and financial-tightness evidence
Pursuing Option 2

- Want model
  - small firms contract more after financial-tightening
  - small and larger firms similar in business cycle downturns

- Ingredients
  - firms born small, grow, stochastically die
  - small firms financially constrained, large not
  - business cycle shocks different from financial shocks
    - symmetric response to business cycle shocks (both hurt)
    - asymmetric response to financial shocks (small hurt more)
Pursuing Option 2

- General setup (generic financial constraint model)
  - Two types of agents
    - managers (entrepreneurs) and workers
    - abstract from workers and stochastic death
  - Enforcement constraints on managers
    - can abscond with fraction of firm’s capital stock
  - Two types of shocks
    - productivity shocks $A_t$ (business cycle shocks)
    - enforcement constraint shocks $\theta_t$ (financial shocks)
Infinite Horizon Deterministic \((A_t, \theta_t)\)

Manager

\[
\max \sum_{t=1}^{\infty} \beta^t c_t
\]

Budget constraint

\[
k_1 + \sum_{t=1}^{\infty} \beta^t [c_t + k_{t+1}] \leq \sum_{t=1}^{\infty} \beta^t A_t F(k_t)
\]

Enforcement constraint

\[
\beta c_1 + \beta^2 c_2 + \beta^3 c_3 + \ldots \geq \beta\theta_1 k_1 \\
\beta^2 c_2 + \beta^3 c_3 + \ldots \geq \beta^2 \theta_2 k_2 \\
\beta^3 c_3 + \ldots \geq \beta^3 \theta_3 k_3
\]

Non-negativity

\[
c_t \geq 0
\]
Proposition: Under sufficient conditions, there exists $T$ such that

1. $c_t = 0, \quad t = 1, \ldots, T$ \hspace{1cm} \text{(backloading is optimal)}

2. $k_{t+1} = \begin{cases} \frac{\theta_t}{\beta \theta_{t+1}} k_t & t < T \\ k^*(A_{t+1}) & t \geq T \end{cases}$

where $k^*(A_t)$ is unconstrained level of capital: $\beta F_k(k^*(A_t)) = 1$

- Small firms run along constraint: only $\theta_t$ matters for invest.
- Large firms unconstrained: $\theta_t$ irrelevant for investment
Implications

- Financial shocks $\theta_t$ asymmetric
  - affect small firms
  - no affect large firms

- Business cycle shocks $A_t$ symmetric
  - direct effect on both small and large sales $A_tF(k_t)$
Spirit of Assumption Needed in Proposition

- Unconstrained level of capital: \( \beta F_k(k^*) - 1 = 0 \)

- Payments to managers: marginal product of labor

\[
\beta c_1 + \beta^2 c_2 + \ldots = [\beta F(k_1^*) - k_1^*] + \beta [\beta F(k_2^*) - k_2^*] + \ldots \\
= [\beta F_k(k_1^*)-1]k_1^* + \beta F_l(k_1^*) + \beta [\beta F_k(k_2^*)-1]k_2^* + \beta^2 F_l(k_1^*) + \ldots \\
= \beta F_l(k_1^*) + \beta^2 F_l(k_1^*) + \ldots
\]

- Assume: unconstrained level of capital not enforceable

\[
\sum_{t=1}^{\infty} \beta^t c_t = \sum_{t=1}^{\infty} \beta^t F_l(k^*) < \beta \theta k_1^*
\]

- Assume: \( A_t \) not vary too much
Why backloading optimal: intuition with $A$ and $\theta$ constant

- Budget constraint pins down p.v. of $c_t$

$$
\sum_{t=1}^{\infty} \beta^t c_t = \sum_{t=1}^{\infty} \beta^t [A_t F(k_t) - k_{t+1}] - k_1 \equiv S
$$

- Try to support $k^*$ in earliest possible period

$$
S = \beta c_1 + \beta^2 c_2 + \beta^3 c_3 + ... \geq \beta \theta k
$$

$$
\beta^2 c_2 + \beta^3 c_3 + ... \geq \beta^2 \theta k
$$

$$
\beta^3 c_3 + ... \geq \beta^3 \theta k
$$

- Suppose enforcement binds at $t + 1$ but $c_t > 0$
  - decrease $c_t$ (put in bank)
  - increase $c_s$, $s > t$ (take out later)
Why backloading optimal: intuition with $A$ and $\theta$ constant

- Budget constraint pins down p.v. of $c_t$

$$\sum_{t=1}^{\infty} \beta^t c_t = \sum_{t=1}^{\infty} \beta^t [A_t F(k_t) - k_{t+1}] - k_1 \equiv S$$

- Try to support $k^*$ in earliest possible period

$$S = \beta c_1 + \beta^2 c_2 + \beta^3 c_3 + ... \geq \beta \theta k$$
$$S = \beta^2 c_2 + \beta^3 c_3 + ... \geq \beta^2 \theta k$$
$$S = \beta^3 c_3 + ... \geq \beta^3 \theta k$$

- Suppose enforcement binds at $t + 1$ but $c_t > 0$
  - No change in p.v. of consumption (still $S$)
  - But relaxes incentive constraints (timing)
Why backloading optimal: intuition with $A$ and $\theta$ constant

- Budget constraint pins down p.v. of $c_t$

$$\sum_{t=1}^{\infty} \beta^t c_t = \sum_{t=1}^{\infty} \beta^t [A_t F(k_t) - k_{t+1}] - k_1 \equiv S$$

- Try to support $k^*$ in earliest possible period

$$S = \beta c_1 + \beta^2 c_2 + \beta^3 c_3 + ... \geq \beta \theta k$$
$$S = \beta^2 c_2 + \beta^3 c_3 + ... \geq \beta^2 \theta k$$
$$S = \beta^3 c_3 + ... \geq \beta^3 \theta k$$

- Suppose enforcement binds at $t + 1$ but $c_t > 0$
- Within finite time $T$: $c_t = 0$, $t = 1, ..., T$

$$S \geq \beta^T \theta k^*$$
How is constrained level determined?

\[ k^* = \frac{\beta F(k) - k}{\theta k} \]

Constraint violated

How Enforcement Constraint Determines Capital Stock

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Conclusion

- Show popular belief is a myth
- Suggested positive research agenda