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Finance and the Real Economy

- 2008 Financial Crisis and Great Recession

- New interest in old questions:
  
  What is the role of financial frictions in business cycles?
  Are recessions with financial crises different?
  How can we measure the financial soundness of firms?

- Today: a contribution to measurement
How is finance linked to the real economy?

• The link we examine: **firms’ financial soundness**

• Our measurement exercise goes ahead of the following theory: heterogeneous firms choose output, employment, investment financial frictions impact activity of financially unsound firms

  **aggregate state:** *cross-section of financial soundness*

  impacts the macroeconomic response to shocks

  leads to amplification and persistence
Why do we care?

- Lots of Theories about financial frictions
- Measurement is missing
What we do

- Measure firms’ financial soundness by **Distance to Insolvency**
  a function of leverage and asset volatility
  statistical view: low distance $\Rightarrow$ likelihood of insolvency is high
  economic view: low distance $\Rightarrow$ financial frictions are high

- Approximate distance to insolvency using equity volatility
  no need to directly measure leverage and asset volatility
  long time series available: show US distribution 1926-2011
What we find

• Distance to insolvency collapsed for all firms
  only during three recessions: 1932-33, 1937, and 2008
  financial and non-financial firms look the same
  this does not happen in other recessions

• What happened in 2008?
  In principle, Distance to Insolvency can fall for two reasons:
  a fall in asset values increases leverage
  an increase in asset volatility makes insolvency more likely
  September 2008, Distance to Insolvency collapsed
  because asset volatility exploded, not because asset value fell

• Financial Crises Look Different, but not as in Standard Theories
Talk Outline

• *Theory* of Firm’s Financial Soundness
  
  Firm’s State Variable: Distance to Insolvency

• *Measurement* of Distance to Insolvency
  
  Use Firm’s Equity Volatility

• *Three Solvency Crises*: 1932-33, 1937, 2008
  
  All Firms Become Unsound
  
  Different from Other Recessions

• What happened in 2008?

• *Directions for Research*
Theory: Firm’s Financial Soundness

State Variable: Distance to Insolvency
Theory: Firm’s Financial Soundness

- **Firm Balance Sheet:** Assets and Liabilities
  
  \( V_{At} \): expected DPV of cash flows from the firm’s assets  
  
  \( V_{Bt} \): DPV of the promised cash flows on liabilities

- **Insolvency** = Assets worth less than Liabilities, \( V_{At} < V_{Bt} \)

- **Financial Soundness** = Distance to Insolvency
  
  Should depend on leverage and asset volatility
  
  Statistical view: low distance \( \implies \) likelihood of insolvency high  
  
  Economic view: low distance \( \implies \) financial frictions are high
Financial Soundness: impact of Leverage

- Combines measure of leverage and measure of riskiness of assets into a single measure of "capital adequacy".

\[
\frac{(V_{At} - V_{Bt})}{V_{At}}: \text{Leverage.}
\]

Value of Firm's Assets and Debt

Time
Financial Soundness: impact of Asset Volatility

Value of Firm's Assets and Debt

\[ \sigma_{At}: \text{Asset volatility} \]

\[ \text{Value of Assets} \quad \text{Debt} \]

\[ \frac{V_{At}}{V_{Bt}}: \text{Leverage.} \]

\[ V_{Et} \quad V_{At} \quad V_{Bt} \text{implies no bankruptcy or default if firm is solvent.} \]

Bankruptcy and default distinct from insolvency.
Financial Soundness = Distance to Insolvency

\[ \left( \frac{V_{At} - V_{Bt}}{V_{At}} \right) \frac{1}{\sigma_{At}} \]

- Value of Assets
- Debt

Distance to Insolvency:
• Combines measure of leverage and measure of riskiness of assets.

- Leverage:
  - \( V_{At} - V_{Bt} \)
- Asset volatility (annualized std dev of innovations to log of asset value)
- Measures value of assets relative to contractual obligations (debt) in units of standard deviation of innovations to assets.

Bankruptcy and default distinct from insolvency.
Distance to Insolvency

- **Definition:** Leverage adjusted to reflect asset volatility
  \[
  \left( \frac{V_{At} - V_{Bt}}{V_{At}} \right) \frac{1}{\sigma_{At}}
  \]

- Firm’s distance to insolvency indicates:
  - Statistical view: likelihood of insolvency
  - Economic view: severity of financial frictions

- Economic costs of low distance to insolvency
  - Lose customers, suppliers, employees
  - Expected bankruptcy costs
  - Bad incentives: debt overhang (equity wants to grab cash)
  - Risk shifting (gambling for redemption)
Talk Outline

Measurement: Distance to Insolvency

Use Firm’s Equity Volatility
How to Measure Distance to Insolvency?

• What we get to see directly:
  
  market values and volatilities of firms’ equity
  
  sometimes accounting information on firms’ liabilities

• What we don’t get to see directly:
  
  values and volatilities of firms’ assets

• Can we measure distance to insolvency in a simple way?

  Yes, with some theory!

  Key finding:  \( \text{Distance to insolvency} \leq 1 / \text{equity volatility} \)
Measurement with Unlimited Liability

- With unlimited liability

  Distance to insolvency $= \frac{1}{\text{equity volatility}}$

- A simple proof

  Value of equity: $V_{Et} = V_{At} - V_{Bt}$

  Volatility of equity: $\sigma_{Et} = \frac{V_{At}}{V_{Et}} \sigma_{At}$

  Plug the first equation into the second one and take inverses:

  $$\frac{1}{\sigma_{Et}} = \left(\frac{V_{At} - V_{Bt}}{V_{At}}\right) \frac{1}{\sigma_{At}}$$
Example with Unlimited Liability

Assets $100, debt $90, asset volatility $\sigma_A = 5\%$

Leverage \[
\frac{V_{At} - V_{Bt}}{V_{At}} = \frac{\$100 - \$90}{\$100} = 10\%
\]

Asset volatility $\sigma_{At} = 5\%$

Distance to Insolvency \[
\left(\frac{V_{At} - V_{Bt}}{V_{At}}\right) \frac{1}{\sigma_{At}} = \frac{10\%}{5\%} = 2
\]
Example with Unlimited Liability

Assets $100, debt $90, asset volatility $\sigma_A = 5\%$
Distance to Insolvency = 2

Equity Value $V_{At} - V_{Bt} = $10

Equity Volatility $\sigma_{Et} = \frac{V_{At}}{V_{Et}} \sigma_A = \frac{$100}{$10} \times 5\% = 50\%$

1/Equity Volatility $\frac{1}{\sigma_{Et}} = \frac{1}{50\%} = 2$

Distance to Insolvency = 2 = 1/equity volatility
Limited Liability: existing literature

- Big literature in finance (Merton, Leland, etc.)
- Model equity’s decision to exercise option of limited liability
- Measure distance to insolvency
  
  Use equity data, accounting data, and structure of model

Commercial Example: Moody’s KMV model
Limited Liability:

- With limited liability

  \[ \text{Distance to Insolvency} \leq \frac{1}{\text{equity volatility}} \]

- Why is the Bound Useful?

  Robust to model misspecification
  
  Does not require any accounting data
  
  Long time series available

- How Tight is the Bound?
Use economic theory to argue the bound is tight

- Creditors lose if they let equity holders run $V_{At}$ below $V_{Bt}$
  
  Equity grabs cash and/or gambles for resurrection

- Strong incentive to write bond covenants to take over firm
  
  creditors want to take over firm when $V_{At}$ reaches $V_{Bt}$

- With aggressive creditors,
  
  distance to insolvency is close to $1 / \text{equity volatility}$

  Theory in online slides

- We use $1 / \text{equity volatility}$ going forward.
\[
\left(\frac{V_A - V_B}{V_A}\right) \frac{1}{\sigma_A} \leq \frac{1}{\sigma_E} = \left(\frac{V_A - X}{V_A}\right) \frac{1}{\sigma_A} \leq \left(\frac{V_A - V_{A^*}}{V_A}\right) \frac{1}{\sigma_A}
\]
Measurement: 1926-2011

- Calculate $\sigma_{Et} =$ standard deviation of daily returns in month
  
  Every NYSE, AMEX, and NASDAQ firm in CRSP
  
  Every month, 1926 to 2011

- Construct cross-section distribution of $1/\sigma_{Et}$ for every month
  
  Start with several hundred firms per month
  
  End with several thousand

- How does this cross-section distribution change in recessions?
What is a low Distance to Insolvency?

- Data on credit ratings and $1/$\text{equity volatility}$ since 1985
1/σ_E by Rating: All Firms
Median Distance to Insolvency

S&P Rating

AAA  AA+  AA  AA-  A+  A  A-  BBB+  BBB  BBB-  BB+  BB  BB-  B+  B  B-  CCC+  CCC  CCC-  CC  C-D

1/σ_E by Rating: All Firms

Safe
$1/\sigma_E$ by Rating: All Firms

**S&P Rating**

- AAA
- AA+
- AA
- A+
- A
- BBB+
- BBB
- BBB-
- BB+
- BB
- BB-
- B+
- B
- B-
- CCC+
- CCC
- CCC-
- CC
- C
- C-D

**Median Distance to Insolvency**

- 10
- 9
- 8
- 7
- 6
- 5
- 4
- 3
- 2
- 1

**Near Default**
$1/\sigma_E$ by Rating: All Firms

Median Distance to Insolvency

S&P Rating

Financials Same as All Firms
What is a low Distance to Insolvency?

- **Above 4**: Good and safe
- **At 3**: Cutoff between Investment Grade and Speculative Grade
- **Below 1**: Bankruptcy or default
Talk Outline

*Three Solvency Crises: 1932-33, 1937, 2008*

All Firms Become Unsound
The Median Firm in the Great Depression
The Median Firm in the Great Depression

![Graph showing the median firm's equity over time, with a green line indicating a safe threshold. The graph plots the inverse of the standard deviation of equity against time, with percentiles marked at 95%, 90%, 75%, 50%, 25%, 10%, and 5%. The graph indicates a decline in equity from January 1926 to April 1937, with a recovery period from April 1937 to April 1940.](image-url)
The Median Firm in the Great Depression

Near Default
The 95th Percentile Firm in the Great Depression

![Graph showing the 95th percentile firm's equity performance over time, with a borderline line at 1/std. equity and various percentile lines such as perc95, perc90, perc75, perc50, perc25, perc10, and perc5.](image-url)
The Great Depression 1926-1940

![Graph showing economic data during the Great Depression]

- $1/\text{std dev equity}$

- Parameters:
  - perc95
  - perc90
  - perc75
  - perc50
  - perc25
  - perc10
  - perc5

The graph illustrates the economic volatility during the Great Depression, with metrics such as standard deviation and equity percentages.
1932-33 and 1937 versus 2008?

• In 1932-33 and 1937
  
  Median firm was close to bankruptcy
  
  The 95th percentile firm was borderline junk

• How does 2008 compare to the Great Depression?
The Median Firm in 2008
The Median Firm in 2008

The chart illustrates the 1/standard deviation of equity per year from January 1997 to April 2011. The green line represents the safe threshold, and the red line indicates the actual 1/std deviation of equity. The chart shows a clear downward trend after 2008, indicating increased risk for the median firm.
The Median Firm in 2008

Near Default
The 95th Percentile Firm in 2008

1/ std dev equity

Jan-97 Oct-97 Jul-98 Apr-99 Jan-00 Oct-00 Jul-01 Apr-02 Jan-03 Oct-03 Jul-04 Apr-05 Jan-06 Oct-06 Jul-07 Apr-08 Jan-09 Oct-09 Jul-10 Apr-11

perc95 perc90 perc75 perc50 perc25 perc10 perc05

Borderline
Talk Outline

  
  All Firms Become Unsound
  
  Financial Firms look similar
Financials Distance to Insolvency 1926-1940

![Chart showing financial distance to insolvency from 1926 to 1940.](chart.png)
Financials Distance to Insolvency 1997-2011

The graph illustrates the financial distance to insolvency from 1997 to 2011. It shows the percentage distance to insolvency for all companies (perc50 All) and financial companies (perc50 Fin) compared to the 50th percentile (perc50) and 95th percentile (perc95) of the insolvency distance. The data points are marked with different colors and line styles to distinguish between the sectors.
Talk Outline

  
  All Firms Become Unsound
  
  Different from Other Recessions
Recession 2001
Distance to Insolvency 1979-1996
Talk Outline

What happened in 2008?

Fall in Asset Values?

Increase in Asset Volatility?
Distance to Insolvency Falls with Leverage

Distance to Insolvency Falls Because Asset Value Falls

Value of Firm's Assets and Debt

Time
Distance to Insolvency Falls with Volatility

Distance to Insolvency Falls Because Asset Volatility Rises
Decomposing Distance to Insolvency

- Decompose Distance to Insolvency into:
  
  Leverage
  
  Asset Volatility

- Use unlimited liability benchmark:
  
  Asset Value = Equity Value + Value of Liabilities
  
  Asset Volatility = Leverage \times Equity Volatility

- Need to use equity and accounting data
  
  COMPUSTAT data for value of liabilities $V_{Bt}$
What Happened in 2008?

- Show Distance to Insolvency
  - Oct. 2007
  - Oct 2008

- Oct 2008 Alternative
  \[(\text{Oct 2007 Leverage}) / (\text{Oct 2008 Asset Volatility})\]

- Main finding: Oct 2008 Alternative is close to Actual
  Much of the change due to change in asset volatility

Distance to Insolvency

Oct-07  Oct-08  Oct 2008 Alt

perc95  perc90  perc75  perc50  perc25  perc10  perc05

2.75  0.88

perc95

Distance to Insolvency

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Oct-07  Oct-08  Oct 2008 Alt
The 95th Percentile Firm Oct 2007 to Oct 2008

Distance to Insolvency

Oct-07

Oct-08

Oct 2008 Alt

perc95   perc90   perc75   perc50   perc25   perc10   perc05

6.15

1.65

2.15

0

1

2

3

4

5

6

7

8

9

10
What Happened Oct 2007 to Oct 2008?
• *Directions for Research*

  Measurement

  History

  Theory
Directions for Research: Measurement

- Alternative measures of financial soundness
  - Bond Spreads (Gilchrist and Zakrajsek)
  - Bond Defaults (Giesecke et. al.)
  - Other Market Signals (Fed Regulation YY)

- Other Countries
  - Are there clear patterns in other crises?
Directions for Research: History

• What happened in the Great Depression?
  
  Financial soundness deteriorated well before Oct. 29
  Missing data on banks
  The financial crisis of 1937?

• Was 2000 to 2008 a failure of regulation?
  
  Financial Soundness was at a high point in early 2007.
Directions for Research: Theory

• Needed: A theory of financial crises that speaks to the data
  Distinctive patterns in firms’ financial soundness
  Affects financial and non-financial firms simultaneously
  Volatility more than leverage
  What is the shock?
  Are banks special?
  Or is firms’ distress a common response to a common shock?
  (e.g. Disaster risk)

• What is the role of financial regulation?