The Financial Soundness of US Firms 1926-2012:
Financial Frictions and Business Cycles

Andrew Atkeson, Andrea Eisfeldt, and Pierre-Olivier Weill

November 2012
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?

  What is the relationship between recessions and financial soundness crises?

  How can we measure the financial soundness of firms?

- We propose a measure for the entire distribution of firms’ financial soundness from 1926-2012.
What we do

- A measurement exercise, going ahead of the following theory:
  heterogeneous firms choose output, employment, investment
  financial frictions impact activity of financially unsound firms
  ⇒ aggregate state = *the cross-section of financial soundness*
What we do

• A measurement exercise, going ahead of the following theory:
  heterogeneous firms choose output, employment, investment
  financial frictions impact activity of financially unsound firms
  \[ \Rightarrow \text{aggregate state} = \text{the cross-section of financial soundness} \]

• Measure firms’ financial soundness by \textbf{Distance to Insolvency}

  \textit{leverage adjusted for asset volatility}

  statistical view: low distance \( \Rightarrow \) likelihood of insolvency is high
  economic view: low distance \( \Rightarrow \) financial frictions are high
    e.g. bankruptcy cost, debt overhang, risk shifting
What we find

• Only three big recessions associated with insolvency crises
  1929-1933, 1937, 2008
  broad: 95% of firms junk
deeep: Average firm well below junk cutoff

• The 2008 insolvency crisis: driven by an increase in asset volatility
  leverage did not play a big role

• Are financial firms special?
  financials resemble non-financials
  but large and “systemic” financials
  exhibited larger financial soundness declines and slower recoveries
Talk Outline

- Theory of firm’s financial soundness
  - firm’s state variable: Distance to Insolvency

- Measurement of Distance to Insolvency

- Calibrating our measuring stick

- Results
  - history of insolvency crises and recessions: 1926-2012
  - leverage vs. volatility
  - are financial firms special?
Theory
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

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

Value of Firm's Assets and Debt

Time
Distance to Insolvency

- **Definition:** Leverage adjusted for asset volatility

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

- The percentage drop in asset value that renders the firm insolvent, measured in units of the firm’s asset standard deviation.
Measurement
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:

  \[ \text{Distance to Insolvency} \leq \frac{1}{\sigma_E} \leq \text{Distance to Default} \]
Measurement with Unlimited Liability

- With unlimited liability

  Distance to insolvency = \( \frac{1}{\sigma_E} \)

- 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:

  \[
  \frac{1}{\sigma_{Et}} = \left( \frac{V_{At} - V_{Bt}}{V_{At}} \right) \frac{1}{\sigma_{At}}
  \]
Measurement with Limited Liability

- Big literature in finance (Merton, Leland, etc.)
- Model equity’s decision to exercise option of limited liability
- Academic empirical work: Duffie (2011) and many others
- Moody’s Analytics (EDF) commercial application of methodology
Limited Liability:

- Our first result:
  \[
  \text{Distance to Insolvency} \leq \frac{1}{\sigma_E}
  \]

- Our second result:
  \[
  \frac{1}{\sigma_E} \leq \text{Distance to Default}
  \]

- Thus \( \text{DI} \leq \frac{1}{\sigma_E} \leq \text{DD} \)
Result 3: How tight is the bound?

- When equity has an option to default
- Distance to Default an upper bound on inverse of equity volatility
- Default point $V_A^\ast < V_B$
- $V_E$ convex in $V_A$
- Implies $\frac{V_A}{\sigma_A} \leq \frac{1}{\sigma_E} = \left(\frac{V_A - X}{V_A}\right) \frac{1}{\sigma_A} \leq \left(\frac{V_A - V_A^\ast}{V_A}\right) \frac{1}{\sigma_A}$

In the diagram, the value of assets is plotted against the value of equity, with $V_A^*$, $X$, $V_B$, and $V_A$ labeled. The equation is visualized with lines representing different scenarios.
Discussion of Bound

- How “close” are DI and DD?
  Creditors lose if they let equity holders run $V_{At}$ below $V_{Bt}$

  Equity grabs cash and/or gambles for resurrection

  Write bond covenants to take over firm at insolvency

  *Aggressive creditors make insolvency and default close*

- Why is the bound useful?
  Robust to model misspecification

  Does not require any accounting data

  Long time series available
Is the approximation any good?
Black and Scholes option adjustment, 1000 firms, 1997-2012
Measurement: 1926-2012

• Use $\frac{1}{\sigma_{Et}}$ to measure Distance to Insolvency monthly for each firm

• 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 $\frac{1}{\sigma_{Et}}$ for every month

  Start with several hundred firms per month
  End with several thousand
Calibrating our measuring stick
What is a low Distance to Insolvency?

- **Above 4**: Good and safe
- **At 3**: Cutoff between Investment Grade and Speculative Grade
- **Below 2**: Not Investment Grade
- **Below 1**: Bankruptcy or default
$1/\sigma_E$ by Rating: All Firms
Ratio of: \( \frac{\text{Prob}(\text{rating}|DI \geq 4)}{\text{Prob}(\text{rating})} \)
Ratio of: Prob(rating|DI<=3) and Prob(rating)
Financials Same as All Firms

Red=All Firms, Blue=Financials
Further validation: $1/\sigma_E$ prior to bankruptcy

![Diagram showing the distance to insolvency over months prior to bankruptcy or delisting with percentiles.(perc5, perc10, perc25, perc50, perc75, perc90, perc95)].
Further validation: $1/\sigma_E$ vs CDS spreads

Log DI vs. Log CDS Spreads 1999-2011 All Firms

log CDS Spread = -1.0456 (log DI) - 3.3591
$R^2 = 0.321$
Insolvency Crises and Recessions

- **A Crisis Definition:**

  A *broad* and *deep* deterioration in financial soundness.

  *Broad:* 95% of firms have Distance to Insolvency below 3.

  *Deep:* Average firm has Distance to Insolvency below 1.

- **3 Broad and Deep Insolvency Crises,**

  1932-33

  1937

  2008

  Coincide with 3 Big Recessions.
Distribution of DI 1926-2012
Broad Insolvency Crises 1926-2012

95th Percentile of DI Distribution

Broad DI Crises: 95% Below 3

October 1929-June 1933

October 1937

May 1940

September 1946

October 1987

October 2008

October 2008
Deep Insolvency Crises 1926-2012

Deep Insolvency Crises: Mean of DI below 1 (Log<0)
Recessions and Insolvency Crises

  
  Almost all Firms Become Unsound
  Average Firm Becomes Very Unsound
  Different from Other Recessions
Leverage vs. Asset volatility
Decomposing Distance to Insolvency

- Decompose Distance to Insolvency into:
  
  Leverage
  
  Asset Volatility

- Use unlimited liability benchmark:
  \[
  V_{At} = V_{Et} + V_{Bt}
  \]

- \[ \frac{1}{\sigma_{Et}} = \frac{V_{At} - V_{Bt}}{V_{At}} \times \frac{1}{\sigma_{At}} \]

- Need to use equity and accounting data
  
  COMPUSTAT data for value of liabilities \( V_{Bt} \)
Decomposition of $\log(\frac{1}{\sigma_{Et}})$
What happened in 2008?

- Much of the collapse in DI is due to a drop in asset volatility
- Not like in standard theories
  in which financial soundness deteriorates...
  ...because $V_A$, and hence $(V_A - V_B)/V_A$, drops
Measurement under limited vs unlimited liability

- We use Black and Scholes to calculate the option adjustment
Are Some Firms Special?

- Financial firms
- Large Financial Firms (TBTF)
- Government-Backed Large Financial Intermediaries (GBLFIs)
Financials vs. Non-Financials DI 1926-2012

mean of log(1/sigma_E) for financial firms
mean of log(1/sigma_E) for non-financial firms
Financials vs. Non-Financials DI 2001-2012

mean of log(1/sigma_E) for financial firms
mean of log(1/sigma_E) for non-financial firms
Are Financial Firms Special?

- DI for Financial Firms
  
  timing and magnitude of collapse of DI
  same as for all firms

- No direct evidence for financials leading a crisis

But, are large financial firms special?
Are Large Financial Firms Special?

- **DI for 50 Largest Financial Firms**
  - timing similar to that for large non-financial firms
  - magnitude greater than that for large non-financial firms
- No direct evidence for greater risk-taking ex-ante.
  - DI ranking of large financials and non-financials switches in 2007
  - Large financials’ recovery is weaker than large non-financials’
Conclusions

Insolvency Crises in three big recessions

Broad: 95% of firms junk
Deep: Average firm well below junk cutoff

Asset volatility, not narrow “leverage” in 2008

DI for Financial Firms resembles that of Non-Financial Firms
But large financials
Exhibited larger DI declines and slower DI recoveries