Topic 5

Financial Market Frictions and Real Activity:

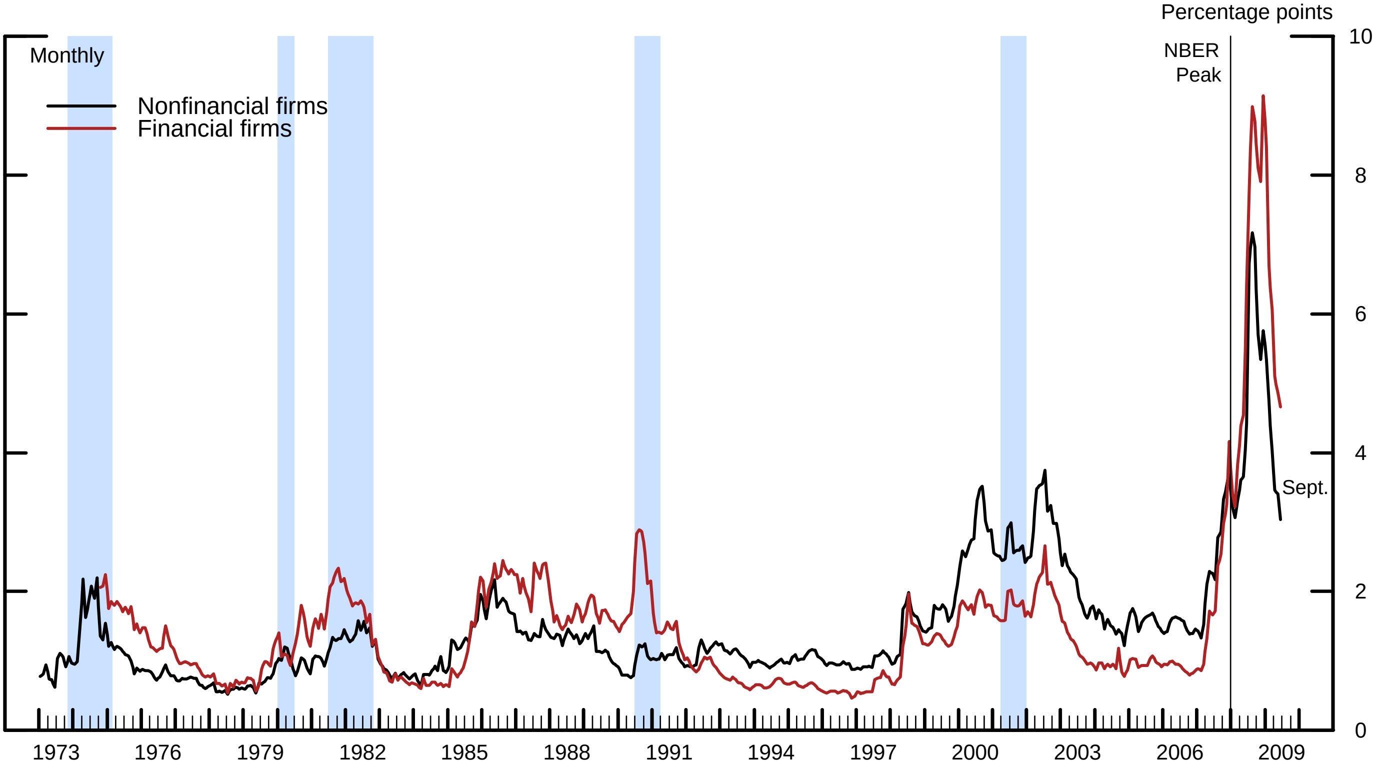
Basic Concepts

Mark Gertler

NYU

Spring 2019

Credit spreads on senior unsecured bonds



Objective

Illustrate the following key concepts:

1. Asymmetric information and/or costly contract enforcement as foundations of financial market imperfections
2. Premium for external finance
3. Rationing vs. non-rationing equilibria
4. Balance sheets and the external finance premium
5. Relation between 4. and leverage constraints
6. Risk, balance sheets constraints and the external finance premium.

Objective (con't)

Illustrate with two simple models:

1. Costly State Verification Model (CSV) (Townsend, 1979)

2. Costly Enforcement Model

Basic Environment

- Two Periods: 0 and 1.

- Risk Neutral Entrepreneur:

  Has project that requires funding in 0 and pays off in 1.

- Competive Risk Neutral Lender:

  Has opportunity cost of funds R.

Basic Environment (con't)

Project Finance:

$$QK = N + B$$

$Q \equiv$ Market Price of a Unit of Captial

$K \equiv$ Capital Input

$N \equiv$ Entrepreneurs's Net Worth (Equity Finance)

$B \equiv$ Debt Finance

Basic Environment (con't)

Period 1 Payoff

$$\widetilde{\omega} R_k \cdot QK$$

$R_k \equiv$ Average Gross Return on Capital

$\widetilde{\omega} \equiv$ Idiosyncratic Shock

Entrepreneur takes $\widetilde{\omega} R_k$ and Q as given, but K is a choice variable.

Basic Environment (con't)

Idiosyncratic Shock Distribution:

$$E\{\widetilde{\omega}\} = 1$$

$$\widetilde{\omega} \ \epsilon \ [0, \overline{\omega}]$$

$$H(\omega) = prob(\widetilde{\omega} \leq \omega)$$

$$h(\omega) = \frac{dH}{d\omega}$$

Perfect Information and Perfect Contract Enforcement

- Given $E\widetilde{\omega}R_k = R_k$, entrepreneurs operates if

$$R_k \geq R$$

where R is the opportunity cost.

- If $R_k > R$, entrepreneur's demand for funds is infinite
  Competitive market forces $\Rightarrow R_k = R$ in equilibrium.

- Miller-Modigliani theorem applies:
  Real Investment Decision is independent of financial structure
  Financial Structure is indeterminate

Private Information and Limited Liability

- Private Information:

  Only entrepreneurs can costlessly observe returns.

  Lenders must pay a cost equal to a fixed fraction μ of the realized return $\omega R_k K$.

  Interpretable as a bankruptcy cost.

- Limited Liability:

  Entrepreneurs minimum payoff bounded at zero.

Private Information and Limited Liability (con't)

Implications:

- Entrepreneur has incentive to misreport returns.
- Financial structure matters to real investment decisions, due to expected bankruptcy costs.
- Financial structure determinate: Designed to reduce expected bankruptcy costs.

Entrepreneur's Optimization Problem:

1. Investment Decision (choice of K)

2. Financial contract: (i) payment schedule baced on ω and (ii) decision to monitor

3. Constraint: Lender must receive opportunity cost in expectation.

Risky Debt as the Optimal Contract

1. Induce Truth-Telling (revelation principle)

2. Minimize Expected Monitoring Costs

$\Rightarrow$

- Optimal Contract is Standard Debt: i.e, Debt with bankruptcy

Risky Debt as the Optimal Contract (con't)

Let $D \equiv$face value of debt and $\omega^* \equiv$ the cutoff value of ω

$$D = \omega^* R_k QK$$

The contract then works as follows:

- If $\omega \geq \omega^*$:

  Lender's payoff is $D = \omega^* R_k QK$; Borrower's payoff is $(\omega - \omega^*) R_k QK$

- If $\omega < \omega^*$,

  The borrower announces default and then the lender monitors.

  Lender's payoff is $(1 - \mu)\omega R_k K$; Borrower's payoff is 0.

- – Observe that the deadweight bankruptcy cost is $\mu\omega R_k QK$.

Risky Debt as the Optimal Contract (con't)

Intuition for Optimal Contract

1. There is no incentive for the entrepreneur to lie:

   In non-default states the payment to lenders is fixed

   In default states there is monitoring.

2. Expected bankruptcy costs are minimized.

   Lender cares about expected return across default and non-default states. By giving the lender everything in the default state, borrower can minimize non-default payment D.

   Given $D = \omega^* R_k QK$, the bankruptcy probability $H(\omega^*)$ is

$$H(\omega^*) = H(\frac{D}{R_k QK})$$

   which is increasing in $D \rightarrow$ minimizing D minimizes expected default costs..

Solving for the Optimal Debt Contract

Given the form of the optimal contract$\Rightarrow$

Lender's expected payment:

$$
\begin{aligned}
[1 - H(\omega *)]D + \int_0^{\omega^*} (1-\mu)\omega R_k Q K dH &= \int_{\omega *}^{\overline{\omega}} \omega^* R_k Q K dH + \int_0^{\omega^*} (1-\mu)\omega R_k Q K \\
&\equiv [\Gamma(\omega^*) - \mu G(\omega^*)] R_k Q K
\end{aligned}
$$

with

$$
\Gamma(\omega^*) \equiv \omega^*[1 - H(\omega *)] + \textstyle\int_0^{\omega^*} \omega dH
$$

$$
G(\omega^*) \equiv \textstyle\int_0^{\omega^*} \omega dH
$$

$\Gamma(\omega^*) \equiv$ Lender's expected gross share of return;

$\Gamma(\omega^*) - \mu G(\omega^*) \equiv$ expected net share

Optimal Contract (con't)

- $\Gamma(\omega^*)$ is increasing and concave

$$\begin{aligned}\Gamma'(\omega^*) &= 1 - H(\omega^*) > 0 \\ \Gamma''(\omega^*) &= -h(\omega^*) < 0\end{aligned}$$

- $G(\omega^*)$ is increasing and convex, assuming $\omega^* h(\omega^*)$ is increasing

$$\begin{aligned}G'(\omega^*) &= \omega^* h(\omega^*) > 0 \\ G''(\omega^*) &> 0\end{aligned}$$

- $\rightarrow \Gamma(\omega^*) - \mu G(\omega^*)$ is concave
  - increasing so long as the default prob $H(\omega^*)$ is not too large

$$\Gamma'(\omega^*) - \mu G'(\omega^*) = 1 - H(\omega^*) - \mu\omega^* h(\omega^*)$$

which is positive under reasonable values for $H(\omega^*), \mu$ and $\omega^* h(\omega^*)$ becomes negative as $\omega^* \rightarrow \overline{\omega}$.

Entrepreneur's Decision Problem

- Objective:

$$\max_{\omega^*,K}\{\max\{[1-\Gamma(\omega^*)]R_k QK, RN\}\}$$

- subject to lender's voluntary participation constraint

$$\begin{aligned}[\Gamma(\omega^*)-\mu G(\omega^*)]R_k QK &= RB \\ & R(QK-N)\end{aligned}$$

$\lambda \equiv$ constraint multiplier $=$ shadow value of N

Entrepreneur's Decision Problem (con't)

F.O.N.C:

- ω^*

$$\lambda = \frac{\Gamma'(\omega^*)}{\Gamma'(\omega^*) - \mu G'(\omega^*)}$$

- K

$$R_k - \frac{\lambda}{\{[1 - \Gamma(\omega^*)] + \lambda[\Gamma(\omega^*) - \mu G(\omega^*)]\}} R = 0$$

- λ

$$[\Gamma(\omega^*) - \mu G(\omega^*)]R_k = R(1 - \frac{N}{QK})$$

Entrepreneur's Decision Problem (con't)

Given $\Gamma'(\omega^*) - \mu' G(\omega^*) > 0 \Rightarrow$ three observations:

1. $\lambda > 1$ and increasing in ω^* (from FONC for ω^*)
   (a) $\rightarrow$Shadow value of net worth $\lambda > 1$ and increasing in $D/R_k QK = \omega^*$

2. ω^* increasing in R_k/R (from FONC for K)
   (a) As $R_k/R \uparrow$, borrowing increases K
   (b) $\rightarrow D/R_k QK = \omega^* \uparrow$ since K is financed at the margin by debt

3. $\frac{\lambda}{\{[1-\Gamma(\omega^*)]+\lambda[\Gamma(\omega^*)-\mu G(\omega^*)]\}} > 1$ is the premium for external finance .
   (a) $\rightarrow R_k > R$
   (b) Premium is increasing in $D/R_k QK = \omega^*$.
   (c) $\rightarrow$ upward sloping supply curve for funds since $D/R_k QK$ increases with K.

4. Optimal Choices of ω^* and K

The following two equations determine ω^* and QK :

- Lender's voluntary participation constraint:

$$[\Gamma(\omega^*) - \mu G(\omega^*)]R_k = R(1 - \frac{N}{QK})$$

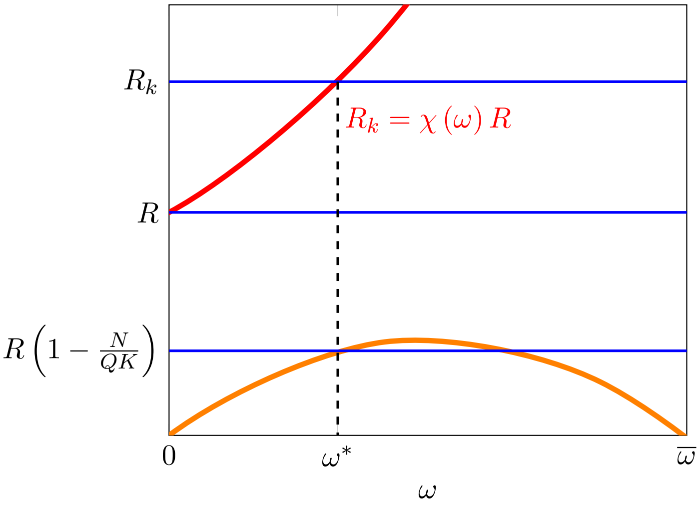
- Optimal Choice of Captial

$$R_k - \chi(\omega^*)R = 0$$

with

$$\chi(\omega^*) = \frac{\lambda(\omega^*)}{\{[1 - \Gamma(\omega^*)] + \lambda(\omega^*)[\Gamma(\omega^*) - \mu G(\omega^*)]\}} > 1; \qquad \chi'(\omega^*) > 0$$

Non-Rationing Equilibrium



The Demand for Capital and Net Worth

- Inverting the lender's voluntary participation constraint:

$$\frac{QK}{N} = \frac{1}{1-[\Gamma(\omega^*)-\mu G(\omega^*)]R_k/R}$$

where $\frac{QK}{N} = 1 + \frac{B}{N} \equiv$ leverage multiple

- ω^* is increasing in R_k/R from FONCs for ω^* and K. $\Rightarrow$

$$\frac{QK}{N} = \phi(\frac{R_k}{R})$$

with $\phi'(\frac{R_k}{R}) > 0$

- $\longrightarrow$Net worth constraint on capital and leverage

$$QK = \phi(\frac{R_k}{R})N$$

$$\Leftrightarrow$$

$$B = [\phi(\frac{R_k}{R}) - 1]N$$

Aggregate Demand for Capital and Financial Crises

- Capital demand

$$QK = \phi(\frac{R_k}{R})N$$

where $\phi(\frac{R_k}{R})$ is the optimal leverage multiple

- $\phi(\frac{R_k}{R})$ does not depend on firm specific factors $\Rightarrow$
  Can aggregate capital demand across entrepreneurs:

$$Q\overline{K} = \phi(\frac{R_k}{R})\overline{N}$$

where $\overline{N}$ is aggregate net worth and $\overline{K}$ is aggregate capital demand.

- Financial Crisis: Sharp drop in N or in $\phi(\frac{R_k}{R})$ that reduces $Q\overline{K}$.

Balance Sheet Strength and the Spread

- Inverting yields

$$\frac{R_k}{R} = \chi(\frac{Q\overline{K}}{\overline{N}})$$

with

$$\chi'(\frac{Q\overline{K}}{\overline{N}}) > 0$$

where χ is the gross spread.

- Thus, in the market equilibrium, the spread is inversely related to aggregate balance sheet strength

  $\Rightarrow$ during a crisis the balance sheet weakens and the spread increases.

Rationing vs. Non-Rationing (Baseline) Case

- Non-Rationing Case ($\Gamma'(\omega^*) - \mu G'(\omega^*) \geqq 0$):
  - 1. Lender's voluntary participation constraint:

$$[\Gamma(\omega^*) - \mu G(\omega^*)]R_k = R(1 - \frac{N}{QK})$$

  - 2a. Optimal Choice of Capital

$$R_k - \chi(\omega^*)R = 0$$

- If at the solution of 1 and 2a $\Gamma'(\omega^*) - \mu G'(\omega^*) < 0$, then the non-rationing case is not an optimum
  - Borrower can raise lender's expected payment by reducing ω^* (since expected default costs decline)
  - Intuitively, the loan supply curve is backward bending over the relevant region $\Rightarrow$ rationing equilibrium.

Rationing Equilibrium

The following two equations determine ω^* and QK :

- Lender's voluntary participation constraint:

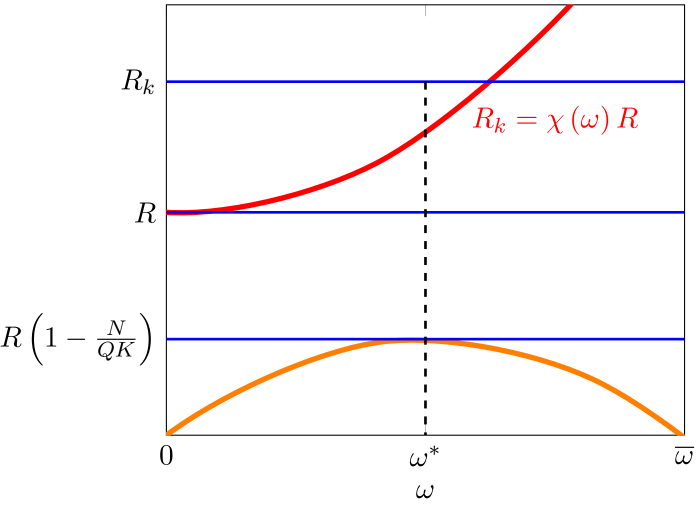
$$[\Gamma(\omega^*) - \mu G(\omega^*)]R_k = R(1 - \frac{N}{QK})$$

- Maximum feasible ω^*

$$\Gamma'(\omega^*) - \mu G'(\omega^*) = 0$$

- Observe that QK varies proportionately with N and with R_k/R. $\Rightarrow$
  - Rationing case has qualitative predictions similar to Non-Rationing Case

Rationing Equilibrium



Idiosyncratic Risk and the Leverage Ratio $\phi(\frac{R_k}{R})$

- Increasing risk can tighten leverage constraints, reducing capital demand:
- Consider a mean preserving spread that:
  - Adds mass to the existing default region $[\underline{\omega}, \overline{\omega}^*]$
  - Does not reduce the density $h(\overline{\omega}^*)$.
- Let ξ be an index of the spread of the distribution of ω.

  Then a mean-preserving spread (increase in ξ) $\Rightarrow$

$$\frac{\partial H(\overline{\omega}^*)}{\partial \xi} > 0$$

  i.e. everyting else equal, a mean-preserving spread increases the default probability $H(\overline{\omega}^*)$.

Increasing Idiosyncratic Risk (con't)

- Lender's Voluntary Participation (LVP) constraint:

$$[\Gamma(\omega^*, \xi) - \mu G(\omega^*, \xi)]R_k = R(1 - \frac{N}{QK})$$

with $\frac{\partial \Gamma(\omega^*,\xi)}{\partial \xi} < 0$ and $\frac{\partial G(\omega^*,\xi)}{\partial \xi} > 0$.

- Optimal Choice of Captial (OCC)

$$R_k - \chi(\omega^*, \xi)R = 0$$

with $\frac{\partial \chi(\omega^*,\xi)}{\partial \xi} > 0$

- From OCC: $\frac{\partial \omega^*}{\partial \xi} < 0$ and from LVP $\frac{\partial K}{\partial \xi} < 0$ (given $\frac{\partial \omega^*}{\partial \xi} < 0$)

Increasing Idiosyncratic Risk (con't)

- Combining equations:

$$\frac{QK}{N} = \phi(\frac{R_k}{R}, \xi)$$

- with

$$\frac{\partial\phi(\frac{R_k}{R}, \xi)}{\partial\xi} < 0$$

- $\Rightarrow$ Increasing idiosyncratic risks reduces capital demand by "tightening margins."

Costly Enforcement Model

- Same basic setup as in CSV model, except the financial market friction is motivated by costs of enforcing contracts as opposed to private information: $\Rightarrow$
- Borrower may decide to renege on debt
- Lender can only recover the fraction $(1-\theta)$ of the gross return $R_k QK$, with $(1-\theta)R_k < R$
- Borrower is able to keep the rest: $\theta R_k QK$

Costly Enforcement Model (con't)

- Value of the project V

$$\begin{aligned} V &= (R_k QK - RB)/R \\ &= [R_k QK - R(QK - N)]R \\ &= (\frac{R_k}{R} - 1)QK + N \end{aligned}$$

- Incentive Constraint:

$$V \geq \theta(R_k QK)/R$$

Entreprenuer's Optimization Problem

- objective

$$\max_K (\frac{R_k}{R} - 1)QK + N$$

- subject to incentive constraint:

$$(\frac{R_k}{R} - 1)QK + N \geq \theta \frac{R_k}{R} QK$$

$\lambda \equiv$ Lagrange Muliplier

$\rightarrow 1 + \lambda =$shadow value of a unit of net worth.

FONCs

- K :

$$\lambda = \frac{\frac{R_k}{R} - 1}{1 - \frac{R_k}{R}(1-\theta)} > 0$$

- λ

$$QK = [\frac{1}{1-(1-\theta)R_k/R}]N$$

$\Rightarrow$

$$QK = \phi(R_k/R)N$$

with $\frac{\partial \phi(R_k/R)}{\partial R_k/R} > 0$

$\longrightarrow$ balance sheets constraint qualitatively similar to one arising from CSV model.

Costly Enforcement Model (con't)

- Advantages

  Less complicated but similar predictions to CSV model:

  1. QK depends positively on N

  2. $\phi(R_k/R)$ is increasing in R_k/R.

Costly Enforcement Model (con't)

Disadvantages

- 1. No default

  2. No credit spreads (as debt is riskless)

  3. Can't analyze shifts in idiosyncratic risk.

  4. Less obvious how to calibrate or estimate parameters.

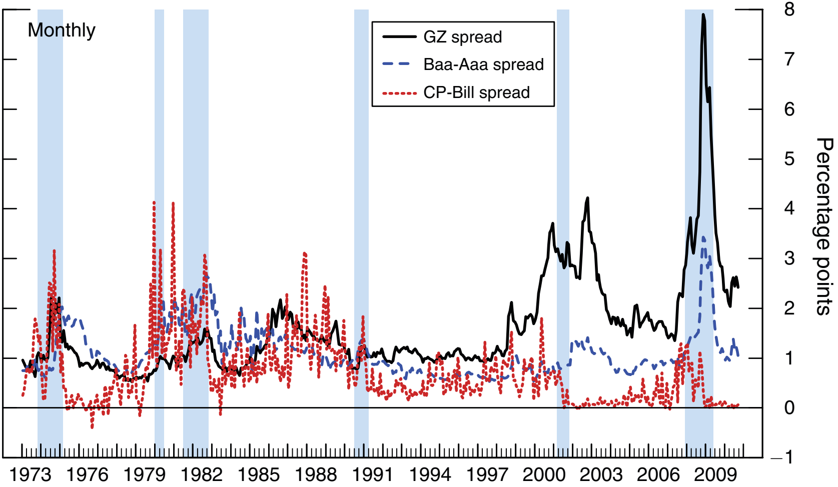


Figure 1. Selected Corporate Credit Spreads

Notes: Sample period: 1973:1–2010:9. The figure depicts the following credit spreads: GZ spread = the average credit spread on senior unsecured bonds issued by nonfinancial firms in our sample (the solid line); Baa–Aaa = the spread between yields on Baa- and Aaa-rated long-term industrial corporate bonds (the dashed line); and CP–Bill = the spread between the yield on one-month A1/P1 nonfinancial commercial paper and the one-month Treasury yield (the dotted line). The shaded vertical bars represent the NBER-dated recessions.

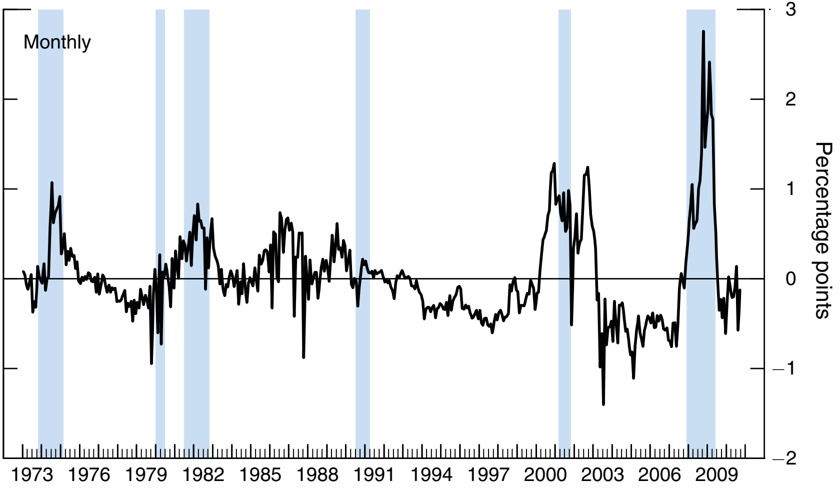


Figure 4. The Excess Bond Premium

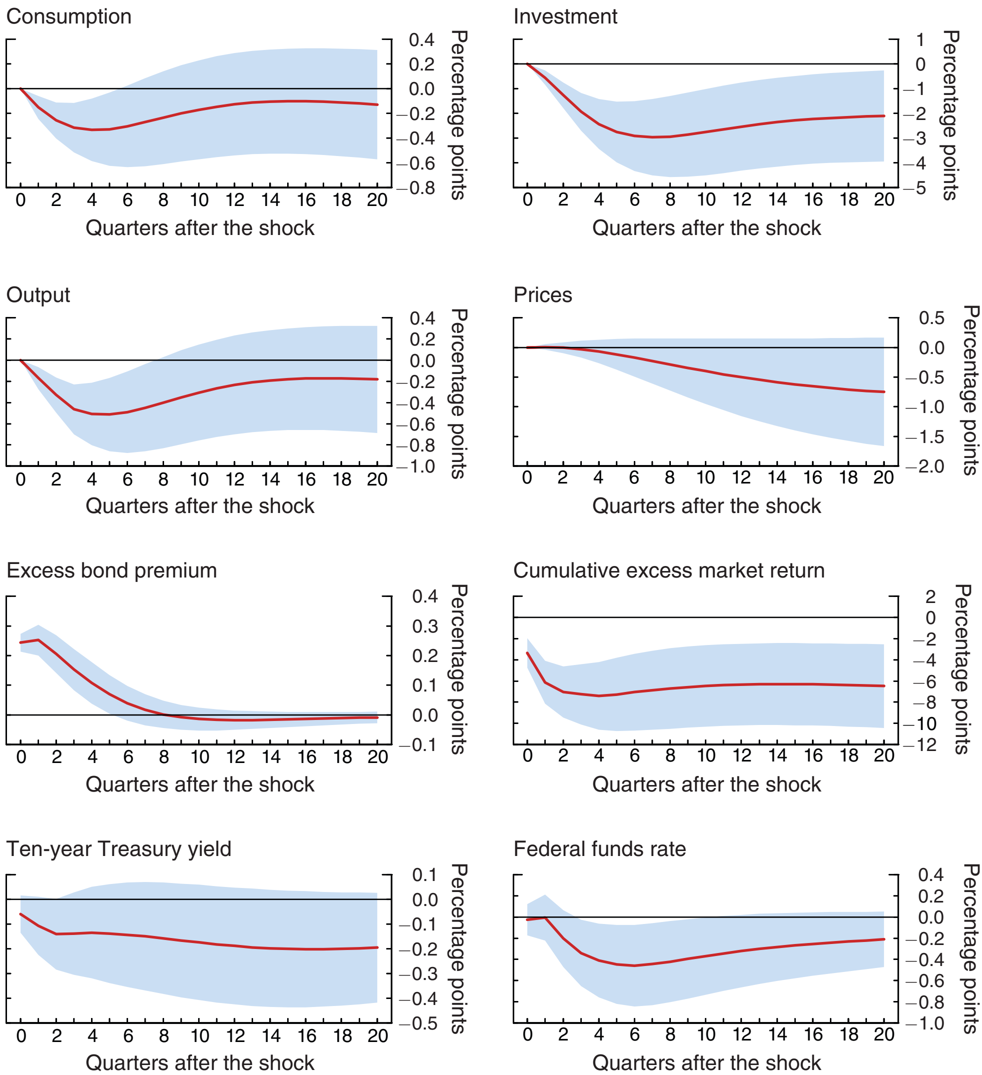


FIGURE 5. MACROECONOMIC IMPLICATIONS OF A FINANCIAL SHOCK

Notes: The figure depicts the impulse responses to a one-standard-deviation orthogonalized shock to the excess bond premium (see text for details). The responses of consumption, investment, and output growth and that of the excess market return have been accumulated. Shaded bands denote 95-percent confidence intervals based on 2,000 bootstrap replications.

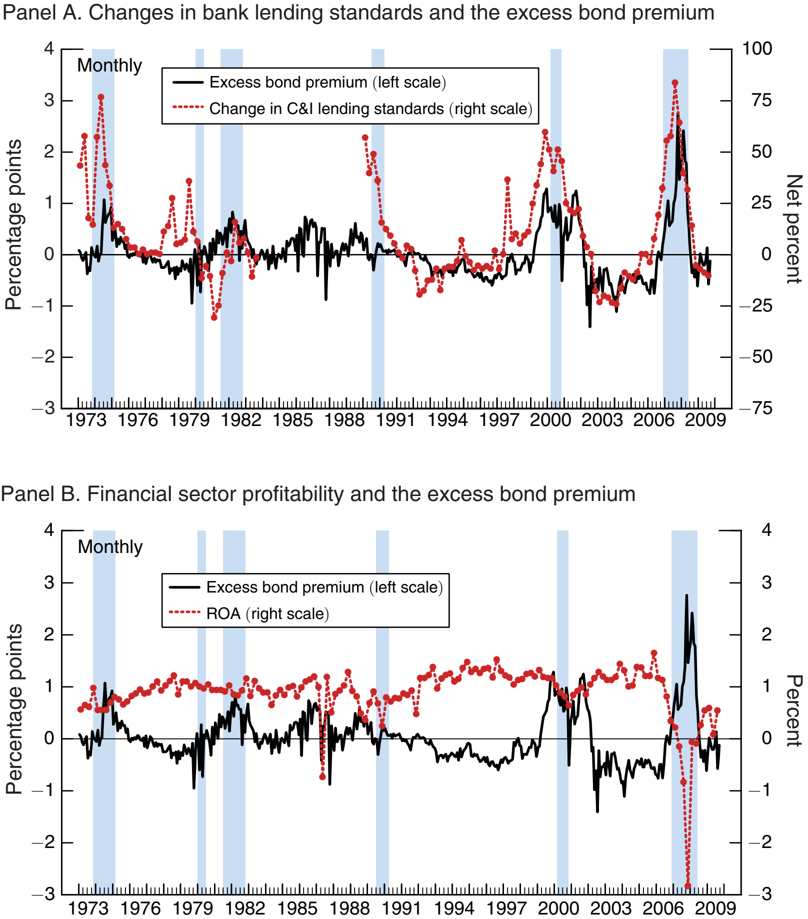


Figure 7. The Excess Bond Premium and Financial Market Conditions

Notes: Sample period: 1973:1–2010:9. The solid line in both panels depicts the estimated (option-adjusted) excess bond premium. The overlayed dots in panel A depict the net percent of SLOOS respondents that reported tightening their credit standards on C&I loans over the past three months. (There was no survey conducted during the 1984–89 period.) The overlayed dots in panel B depict the quarterly (annualized) ROA for the US financial corporate sector, calculated using Compustat data. The shaded vertical bars denote the NBER-dated recessions.

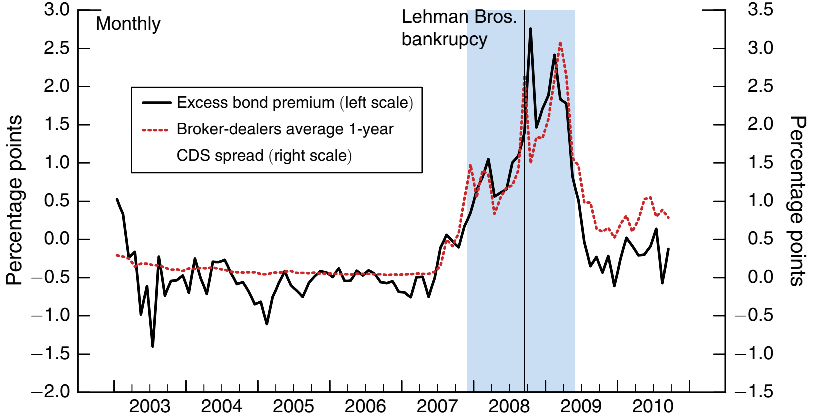


FIGURE 8. THE EXCESS BOND PREMIUM AND FINANCIAL INTERMEDIARY CDS SPREADS

Notes: Sample period: 2003:1–2010:9. The solid line depicts the estimated excess bond premium. The overlayed dotted line depicts the average one-year CDS spread of broker-dealers. The shaded vertical bar represents the 2007–09 NBER-dated recession.