The Magnitude and Cyclical Behavior of Financial Market Frictions

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April 27, 2004

The Modigliani–Miller Theorem

In a world of no financial market imperfections, capital structure is indeterminate and the aggregate mix of debt vs. equity is irrelevant for the evolution of the real economy.

The MM theorem has provided an important justification for abstracting from financing decisions in models of macroeconomic fluctuations:

- IS-LM framework
- Real business cycle models
- Canonical new-Keynesian model

Financial Market Frictions: Theory

The seminal work of Bernanke & Gertler (1989) shows that financial factors can play an important role in the propagation of aggregate shocks—the *financial accelerator*.

- Debt-deflation during the Great Depression
  Fisher (1933)

- Asymmetric information theory
  Akerlof (1970), Stiglitz & Weiss (1981), etc.

- Micro-founded DGE models with financial market frictions
  Carlstrom & Fuerst (1997), Kiyotaki & Moore (1997), etc.

- Open-economy research stimulated by the Asian crisis
  Krugman (1999), Gertler, Gilchrist, & Natalucci (2003), etc.

Financial Market Frictions: Evidence

The quantitative significance of financial market frictions has remained elusive despite substantial empirical work:

- Reduced-form evidence linking balance-sheet variables to investment and employment

  Gurley & Shaw (1960), etc.

- Structural analysis using proxies for capital market access (e.g., small vs. large firms, rated vs. non-rated firms)

  Fazzari et al. (1988), Gilchrist & Himmelberg (1995), etc.

  Critique: Cummins et al. (1994), Kaplan & Zingales (1997), etc.

Financial Market Frictions: Evidence (contd.)

- Matching VAR-based impulse response functions

  Bernanke et al. (1999), Christiano et al. (2003), etc.

  Chari et al. (2003), Lee & Ohanian (2003)

Missing: Direct estimates of the magnitude of financial frictions

Outline

- Revisit microfoundations of BGG (1999) financial accelerator model
- Analyze firm-level panel data linking credit spreads, market-based measures of default risk, and balance sheet variables
- Directly estimate the magnitude of financial frictions
- Examine the behavior of model-implied external finance premium during the most recent economic downturn
- Directions for future research

Summary of Results

We obtain precise time-specific estimates of the structural parameter measuring the extent of financial market frictions.

We clearly reject the null hypothesis of frictionless capital markets for the 1997–2003 period.

The degree of financial frictions exhibits a strong cyclical pattern:

- Between 1997 and mid-2000, our estimates are very close to calibrated values used in previous research.

- The estimated degree of financial frictions rises by a factor of 2 during the latest economic downturn, before returning to pre-recession levels in 2003.

Overview of the BGG Framework

Bankruptcy Costs: lender incurs costs proportional to total value of the firm if borrower defaults, giving rise to the *external finance premium*

Leverage-Spread Schedule: inverse relationship between the firm's net worth and its borrowing costs

Sources of Declining Net Worth: declines in equity prices and/or unexpected deflation

Amplification of Shocks: procyclical net worth leads to countercyclical external finance premium, enhancing swings in borrowing, investment, and output

Microfoundations of the BGG Framework

Total Return to Capital: $\omega_i R^k Q K_i$, where R^k (return to capital) and Q (price of capital) are known to both lender and entrepreneur:

$$\begin{aligned} R^k &> R \quad (R = \text{risk-free rate}) \\ QK_i &= B_i + N_i \quad (\text{value of firm} = \text{debt} + \text{net worth}) \end{aligned}$$

Idiosyncratic Productivity Shock: $\omega_i \sim f(\omega)$, with $E(\omega) = 1$

Costly-State Verification: lender can only observe ω_i by paying $\mu\omega_i R^k Q K_i$, where $0 < \mu < 1$ (i.e., bankruptcy costs)

The Optimal Debt Contract

The optimal debt contract specifies loan amount B_i and default productivity threshold $\overline{\omega}_i$:

- **No Default**: if $\omega_i \geq \overline{\omega}_i$, entrepreneur pays $R^b B_i$ to lender, where

  $$R^b B_i = \overline{\omega}_i R^k Q K_i$$

  and entrepreneur keeps $(\omega_i - \overline{\omega}_i) R^k Q K_i$.

- **Default**: if $\omega_i < \overline{\omega}_i$, then entrepreneur gets 0, and lender receives $(1 - \mu)\omega_i R^k Q K_i$.

The Optimization Problem

Choose loan amount B_i and default productivity threshold $\overline{\omega}_i$ to

$$\begin{aligned} \max \quad & \psi(\overline{\omega}_i) R^k (B_i + N_i) \\ \text{s.t.} \quad & \\ & \xi(\overline{\omega}_i; \mu) R^k (B_i + N_i) = R B_i \end{aligned}$$

- $\psi(\overline{\omega}_i) R^k (B_i + N_i) =$ expected return to entrepreneur:

$$\psi(\overline{\omega}_i) = \int_{\overline{\omega}_i}^{\infty} (\omega_i - \overline{\omega}_i) f(\omega) d\omega$$

- $\xi(\overline{\omega}_i; \mu) R^k (B_i + N_i) =$ expected return to lender:

$$\xi(\overline{\omega}_i; \mu) = (1 - \mu) \int_0^{\overline{\omega}_i} \omega_i f(\omega) d\omega + \overline{\omega}_i \int_{\overline{\omega}_i}^{\infty} f(\omega) d\omega$$

The Optimization Problem (contd.)

From definitions and FOCs, we obtain:

$$\frac{R^k}{R} = \frac{\psi'(\overline{\omega}_i)}{\psi(\overline{\omega}_i)\xi'(\overline{\omega}_i;\mu) - \psi'(\overline{\omega}_i)\xi(\overline{\omega}_i;\mu)} \quad (1)$$

$$\frac{B_i}{N_i} = -\frac{\psi'(\overline{\omega}_i)\xi(\overline{\omega}_i;\mu)}{\psi(\overline{\omega}_i)\xi'(\overline{\omega}_i;\mu)} \quad (2)$$

$$\frac{R^b}{R} = \overline{\omega}_i \left(1 + \frac{B_i}{N_i}\right) \frac{R^k}{R} \quad (3)$$

Analytical solutions to 1–3 obtained by assuming log-normality:

$$\ln \omega \sim \mathrm{N}\left(-\frac{\sigma^2}{2}, \sigma^2\right)$$

Figure 1A: Implications of Monitoring Costs

(annual rates in percent)

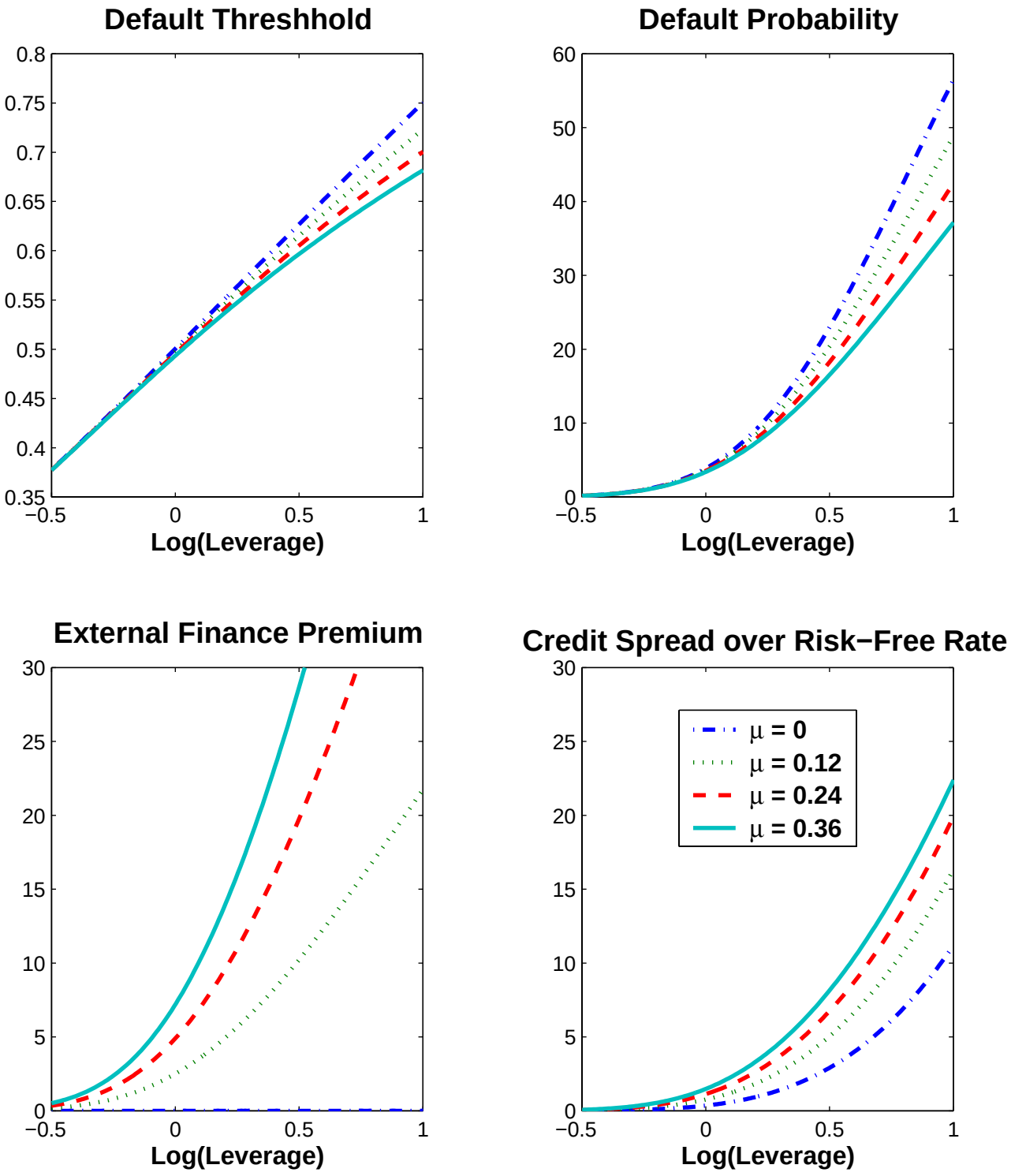
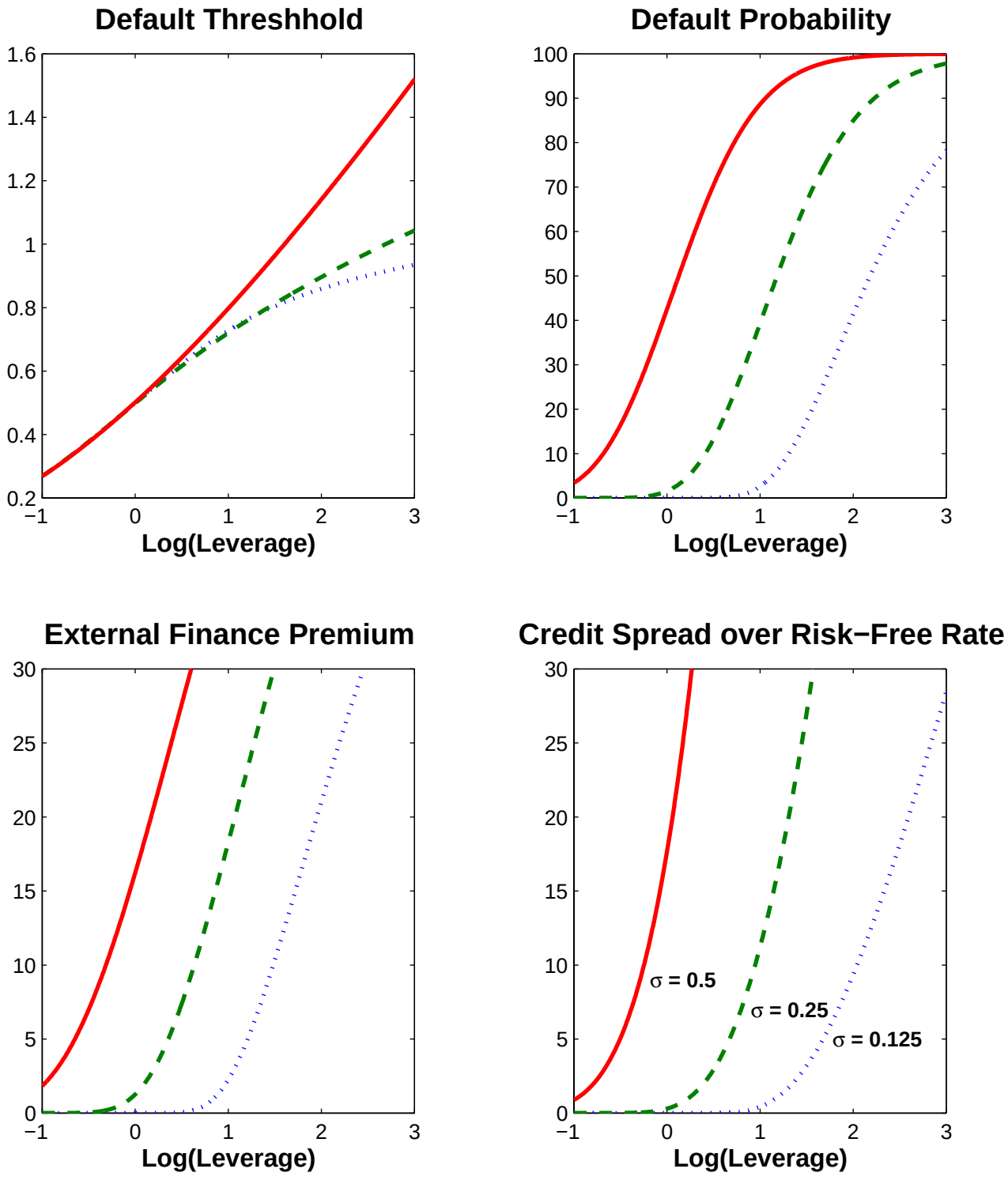


Figure 1B: Implications of Idiosyncratic Risk

(annual rates in percent)



Data Description

We linked firm-level data from the following sources:

- Compustat: income and balance sheet variables (quarterly)
- Merrill Lynch: yields on outstanding publicly-traded corporate securities (daily)
- Moody's/KMV: expected default probabilities (monthly)

Data Description (contd.)

Panel dimensions:

- 918 nonfinancial publicly-traded corporations
- sample period: 1997Q1–2003Q3 (27 quarters)
- 14,124 total observations
- min. tenure = 4; median tenure = 14; max. tenure = 27

Key Variables

Leverage Ratio: book value of long-term debt relative to market capitalization

Credit Spreads: corporate yield less estimated Treasury yield

- Treasury yield curve estimated daily (Svensson, 1994)
- tax adjustment (Cooper & Davydenko, 2002)

Default Probabilities: expected default frequencies (EDFs)

- option-theoretic approach to calculate a firm-specific distance to default (DD)
- actual defaults used to construct a statistical mapping from DD to EDF

Summary Statistics

Variable	Min	Median	Max
Sales ($ bil.)	0.002	0.7	57
Mkt. Capitalization ($ bil.)	0.006	2.2	309
Leverage Ratio[a]	0.02	0.50	15.9
Credit Spread (%)	0.3	2.3	29
No. of Issues Traded	1	2	59
Avg. Portfolio Maturity (years)	1	8	30
Share of Traded Debt[b] (%)	2	51	100
S&P Credit Rating	C2	BBB3	AAA
Expected Default Frequency (%)	0.02	0.6	20

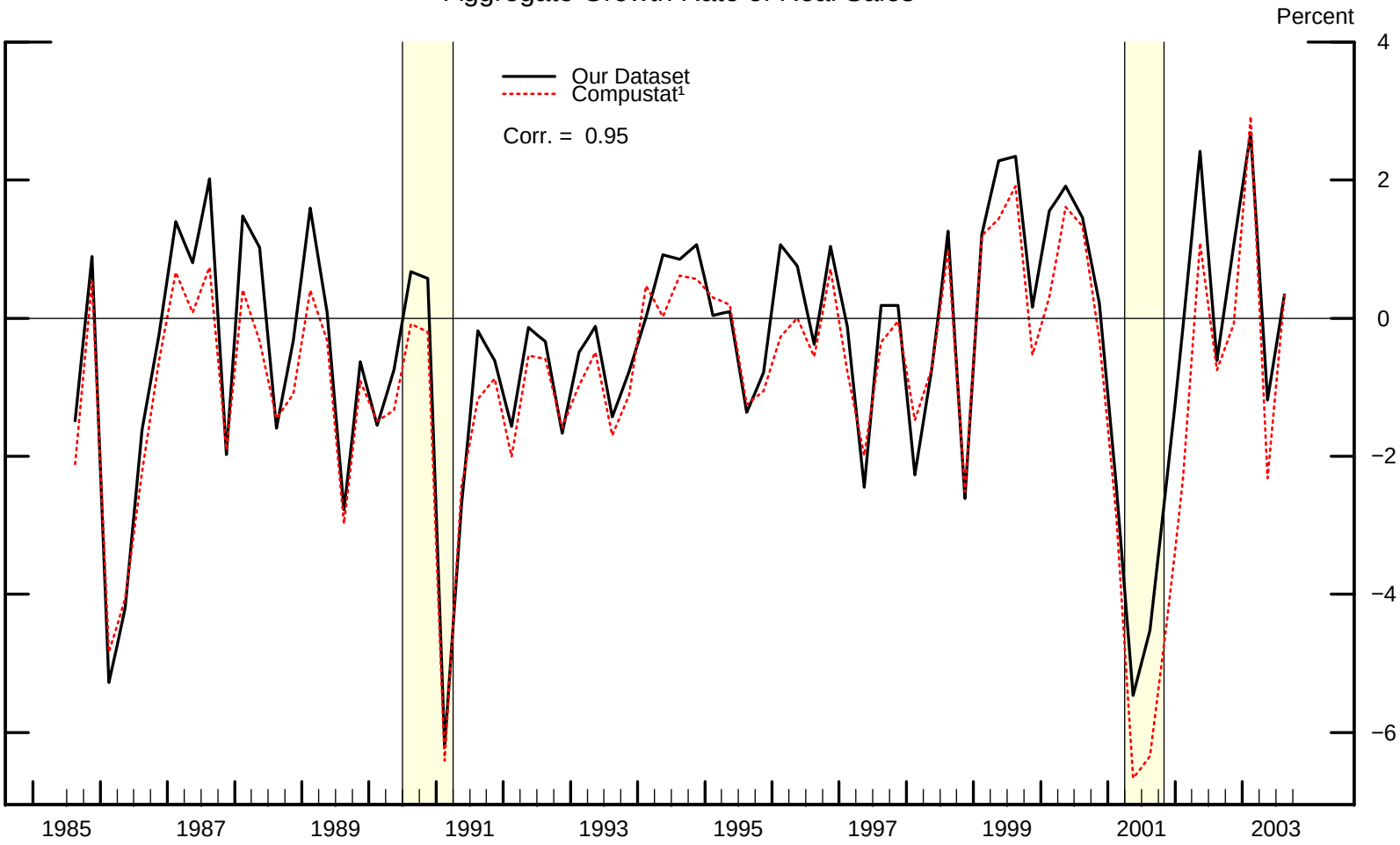
[a]The book value of long-term debt relative to market capitalization.

[b]The book value of traded bonds relative to the book value of total long-term debt.

Figure 2A

Corporate Balance Sheets

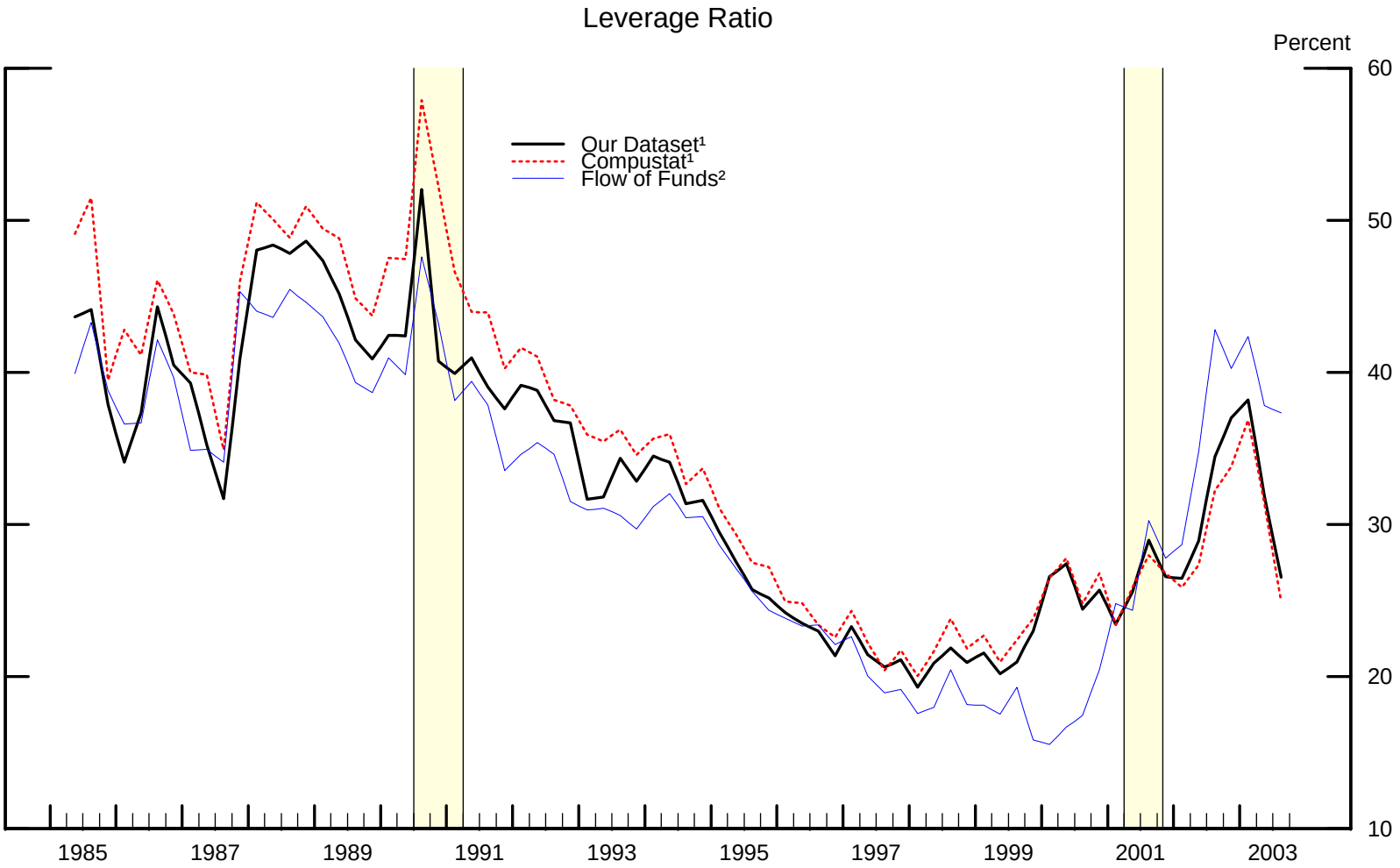
Aggregate Growth Rate of Real Sales



Note. Data are seasonally adjusted.
¹ All nonfinancial corporations.

Figure 2B

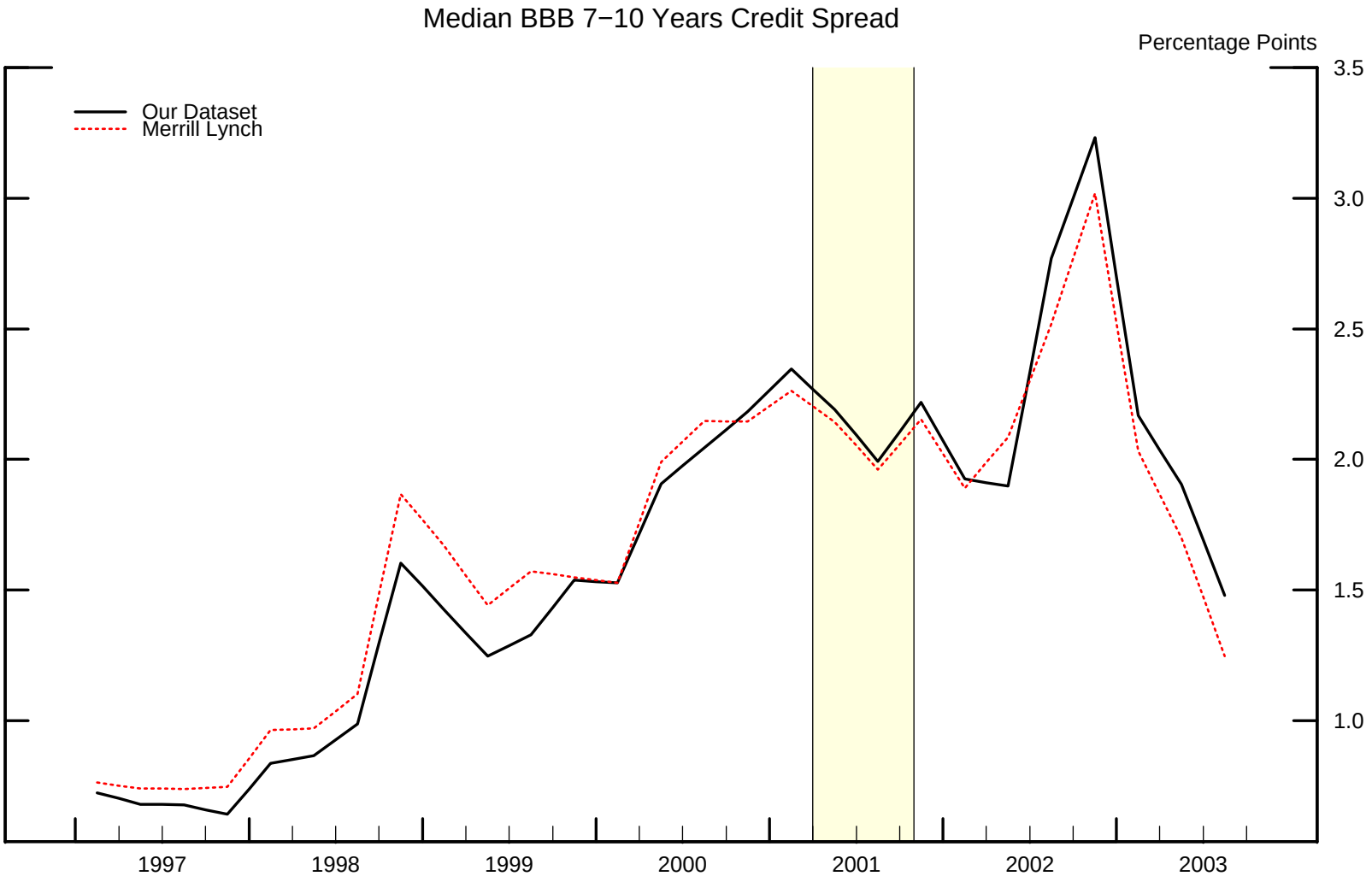
Corporate Balance Sheets



Note. Data are seasonally adjusted.
¹ Median book value of long−term debt relative to market value of equity, weighted by firm sales.
² Book value of bonds and mortgages relative to market value of equity for nonfinancial corporations.

Figure 3A

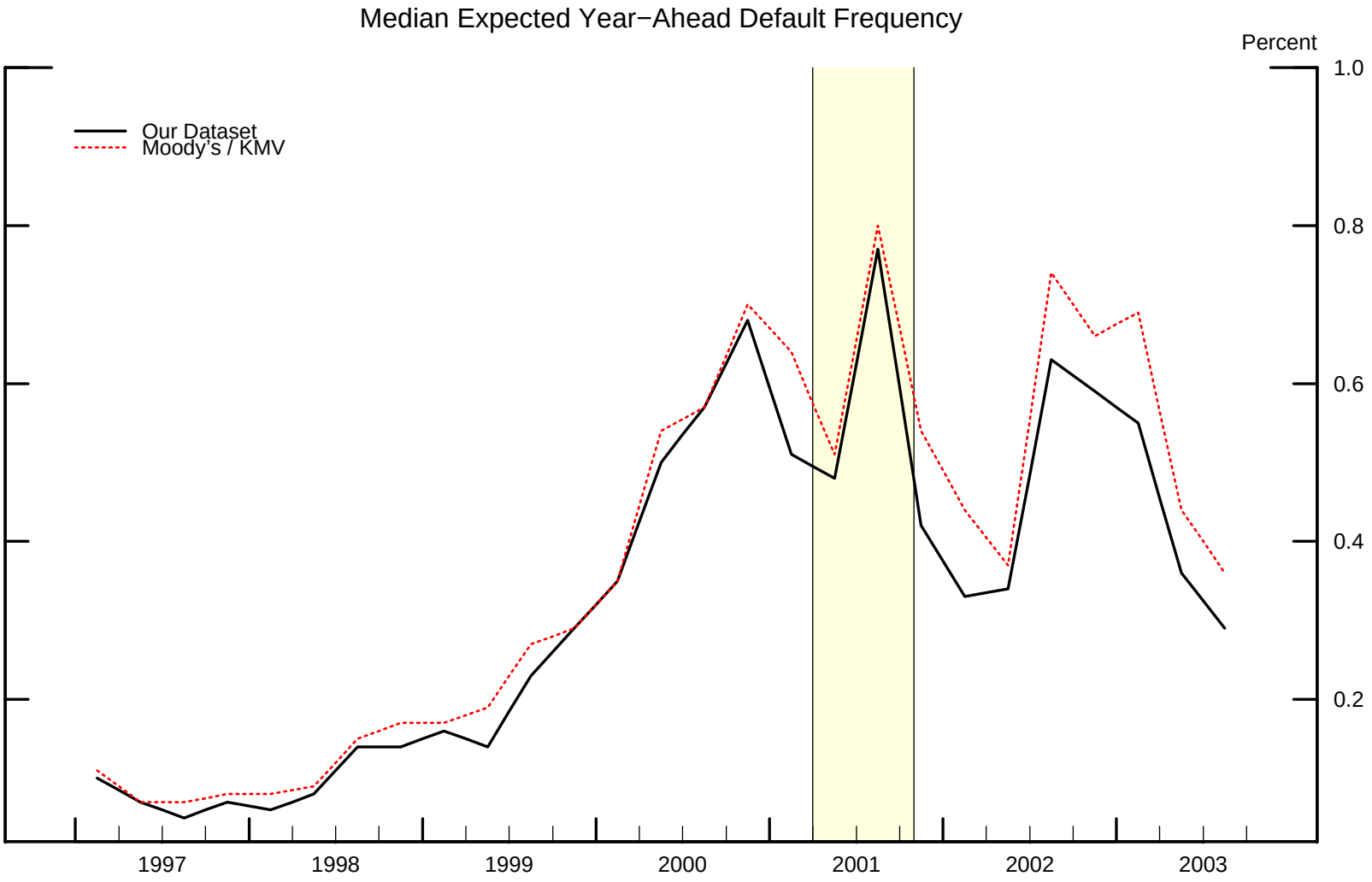
Corporate Credit Spreads



Note. Medians are weighted by the market value of bonds outstanding. Merrill Lynch data are for all nonfinancial issues.

Figure 3B

Corporate Credit Quality



Note. Firm−level estimates of default weighted by firm liabilities.

Figure 4A

Leverage and Credit Spreads

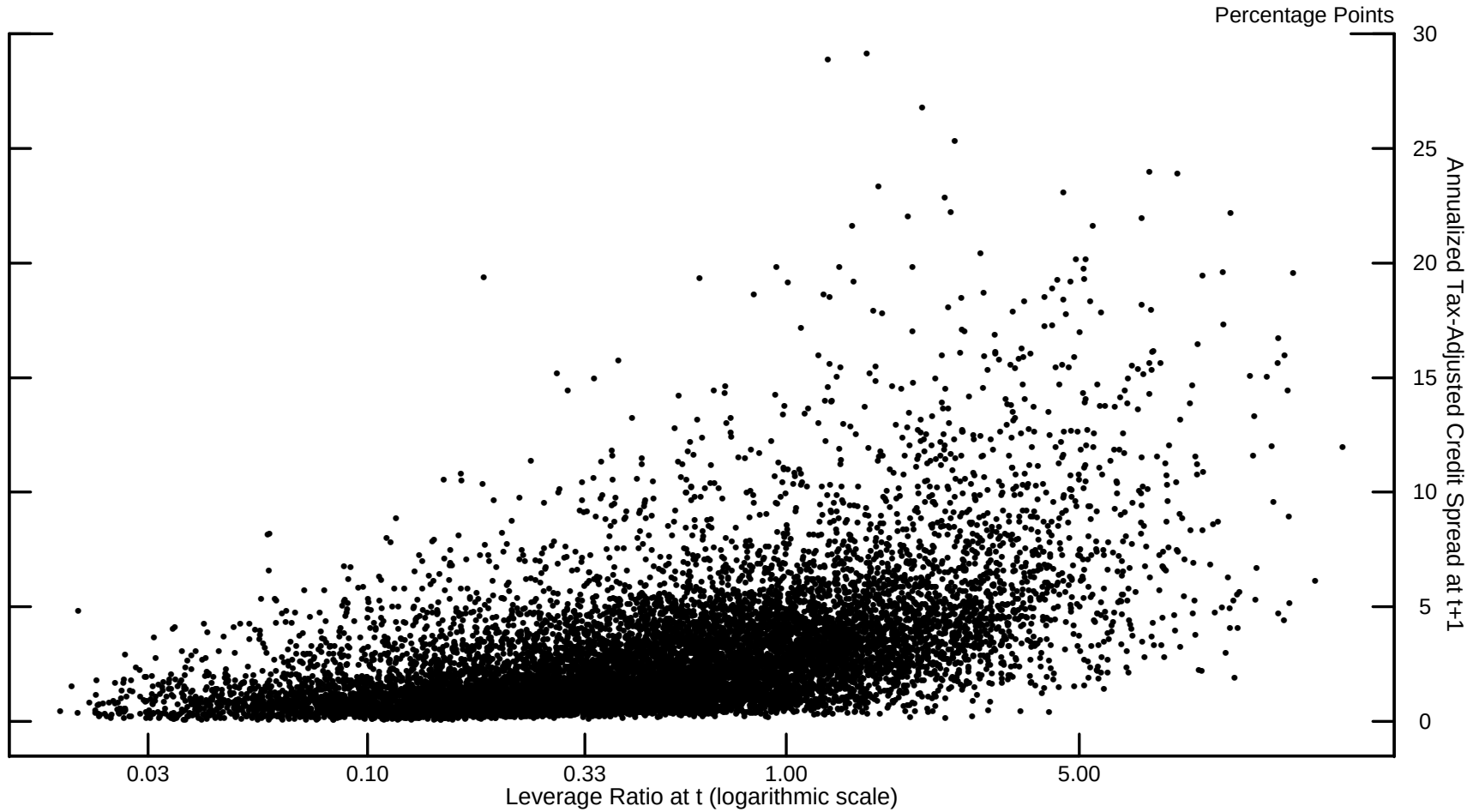
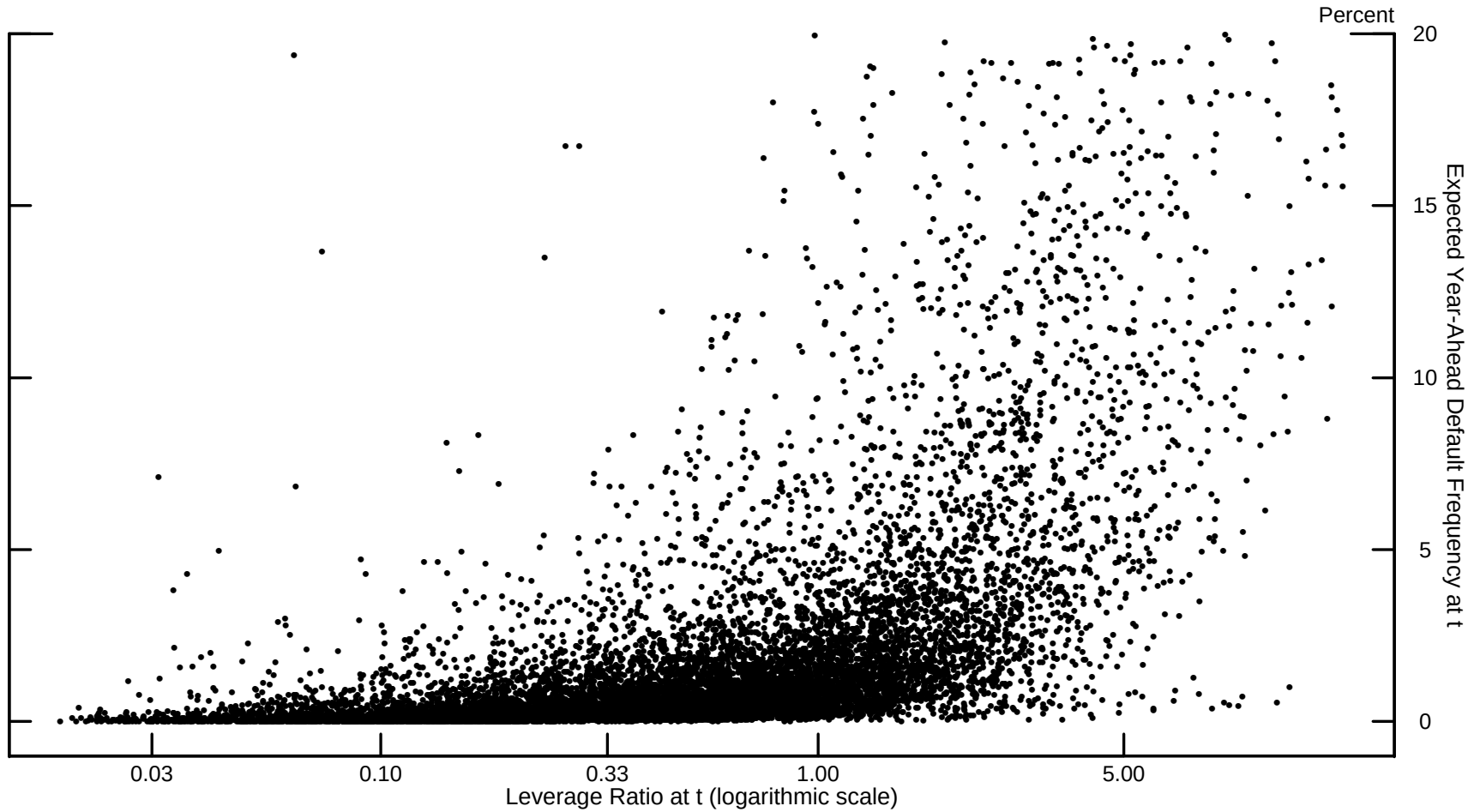


Figure 4B

Leverage and Expected Probabilities of Default



Estimation Methodology

Assumptions:

- Productivity shock: $\ln \omega_{it} \sim \mathrm{N}(-0.5\sigma_{it}^2, \sigma_{it}^2)$
- Bankruptcy costs: μ_t common across firms but can vary over time.

In period t, given μ_t, solve for $\overline{\omega}_{it}$ and σ_{it}

$$\left[\frac{B}{N}\right]_{it-1} = -\frac{\psi'(\overline{\omega}_{it}, \sigma_{it})\xi(\overline{\omega}_{it}, \sigma_{it}; \mu_t)}{\psi(\overline{\omega}_{it}, \sigma_{it})\xi'(\overline{\omega}_{it}, \sigma_{it}; \mu_t)}$$

$$\mathrm{EDF}_{it-1} = \Phi\left(\frac{\ln \overline{\omega}_{it} - 0.5\sigma_{it}^2}{\sigma_{it}}\right) \qquad \Phi(\cdot) = \text{standard normal c.d.f.}$$

Estimation Methodology (contd.)

Solutions $\overline{\omega}_{it}^{*}$ and σ_{it}^{*} imply a contractual credit spread

$$\left[\frac{R^b}{R}\right]_{it}^{*} = \overline{\omega}_{it}^{*}\left(1+\left[\frac{B}{N}\right]_{it-1}\right) \times\left(\frac{\psi'(\overline{\omega}_{it}^{*},\sigma_{it}^{*})}{\psi(\overline{\omega}_{it}^{*},\sigma_{it}^{*})\xi'(\overline{\omega}_{it}^{*},\sigma_{it}^{*};\mu_t)-\psi'(\overline{\omega}_{it}^{*},\sigma_{it}^{*})\xi(\overline{\omega}_{it}^{*},\sigma_{it}^{*};\mu_t)}\right)$$

Difference between actual and model-implied credit spreads

$$\left[\frac{R^b}{R}\right]_{it} - \left[\frac{R^b}{R}\right]_{it}^{*} = \mathsf{RATING}_{it-1} + u_{it}$$

Estimation Methodology (contd.)

RATING$_{it-1}$ is a fixed effect for firm i's credit rating at the end of period $t-1$ (i.e., liquidity premiums)

u_{it} is a mean-zero error term

Objective: Choose μ_t to minimize $\sum_{i=1}^{N} u_{it}^2$

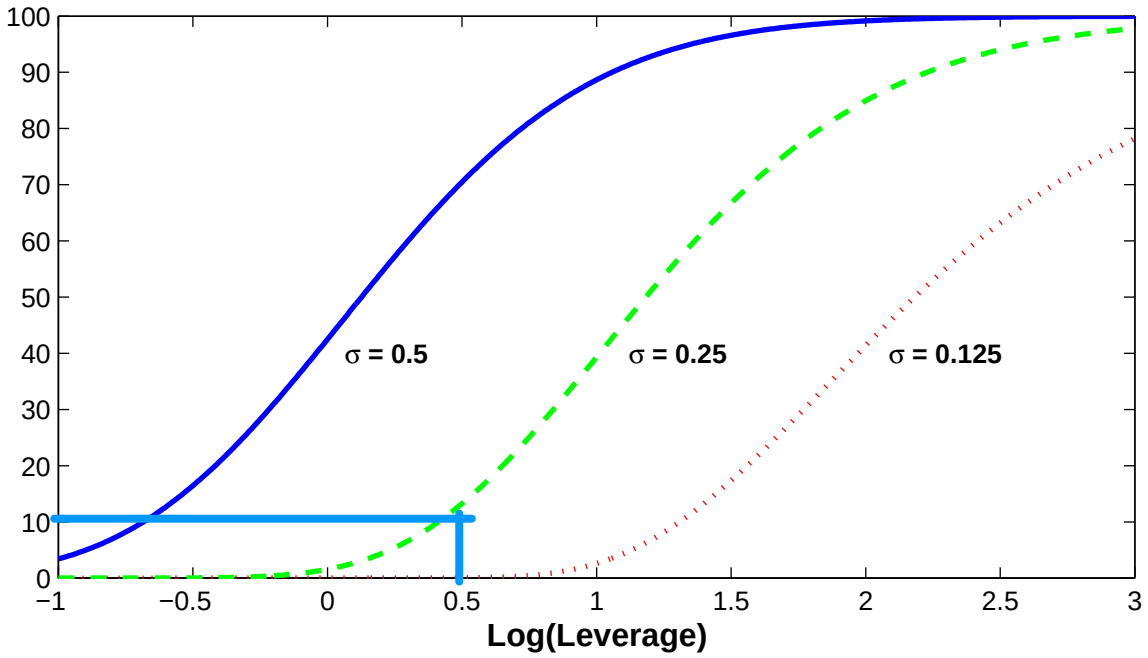
Robustness check:

- trimmed data (2.5$^{\text{th}}$ Pctl. $\leq$ leverage $\leq$ 97.5$^{\text{th}}$ Pctl. and spreads $\leq$ 97.5$^{\text{th}}$ Pctl.)
- LAD estimates

Estimation Methodology

(annual rates in percent)

Default Probability



Credit Spread

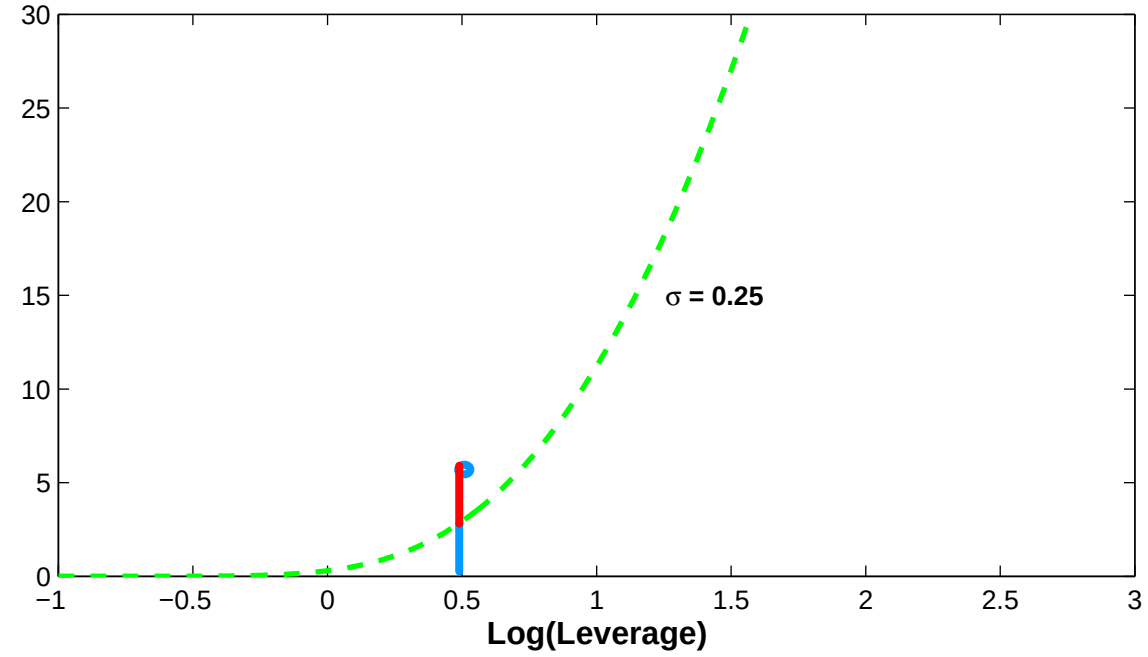
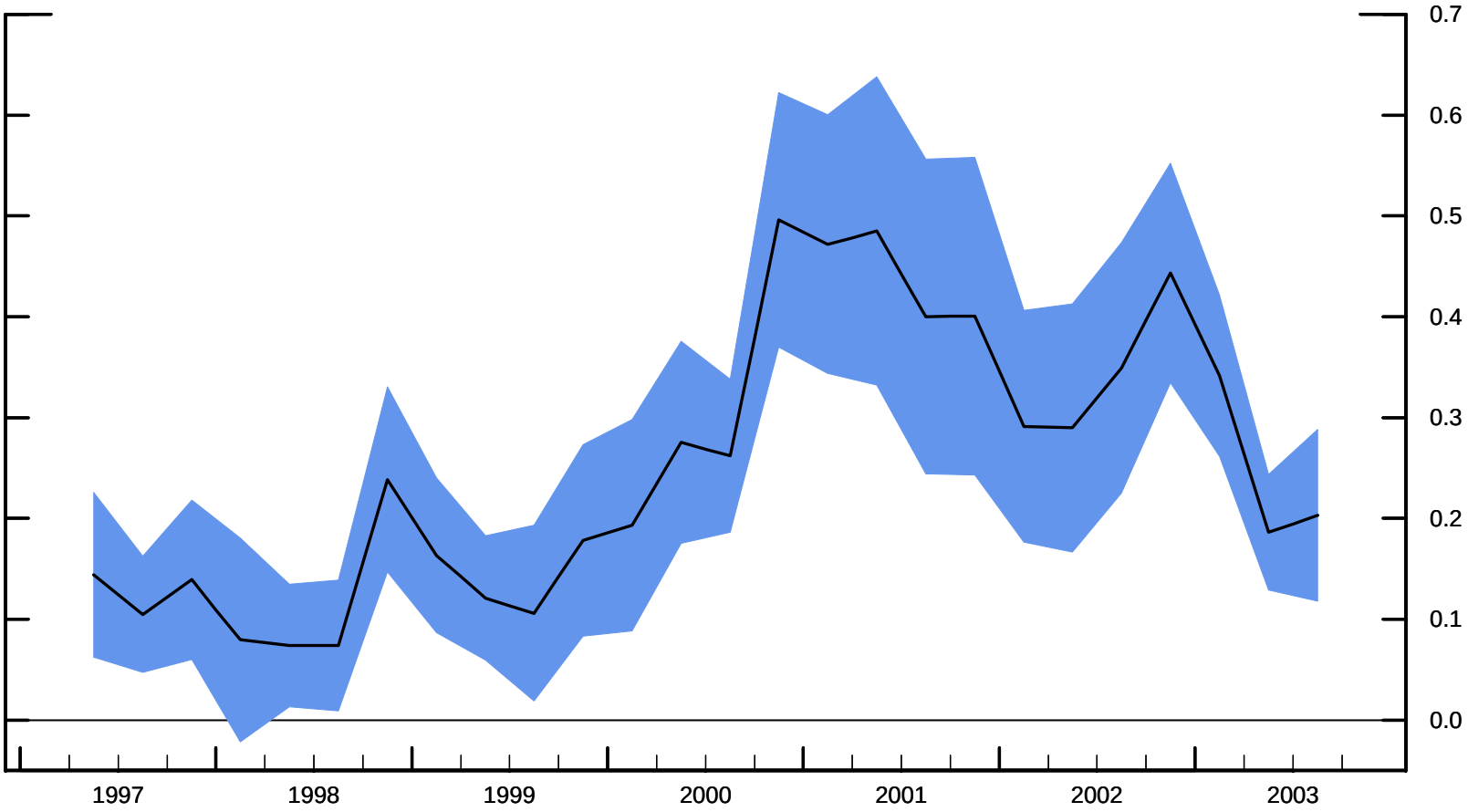


Figure 5A

The Magnitude of Financial Market Frictions

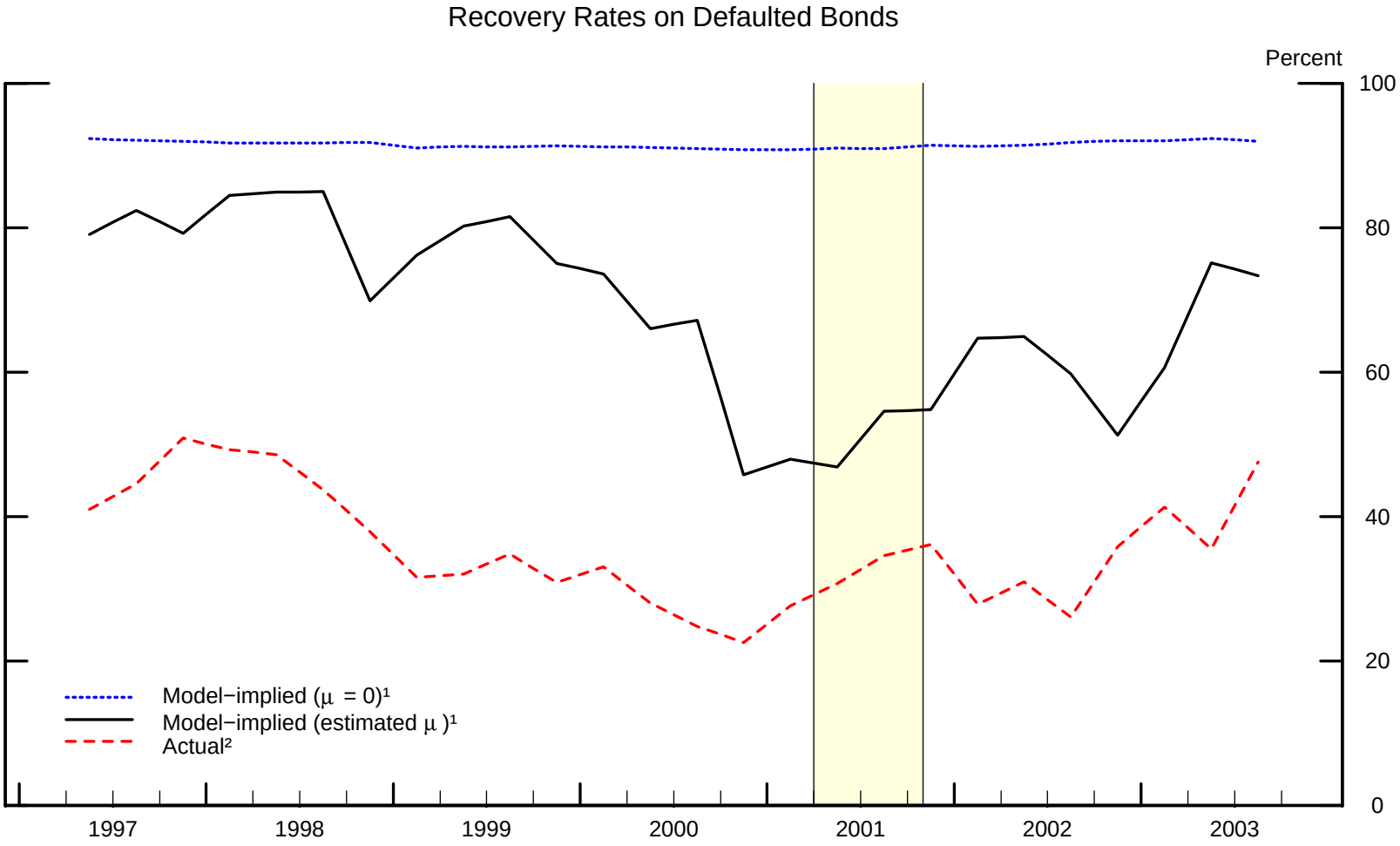
NLLS Estimates of the Bankruptcy Cost Parameter μ



Note. The shaded region represents +/− 2 standard error bands computed using a heteroscedasticity−consistent asymptotic covariance matrix. The model includes fixed credit rating effects (see text for details).

Figure 5B

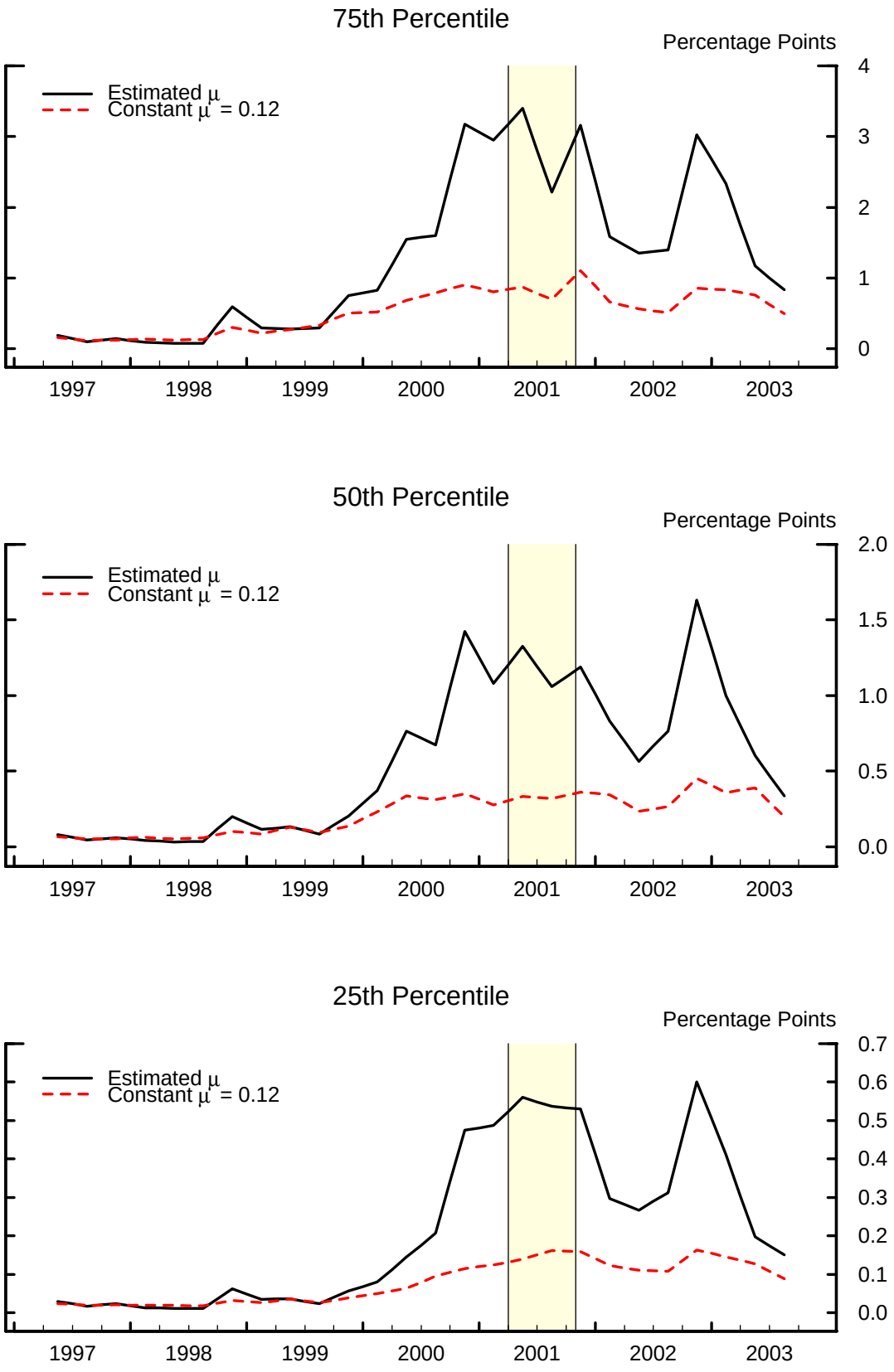
The Magnitude of Financial Market Frictions



¹ Average model−implied recovery rate weighted by the book value of bonds outstanding.
² Average recovery rate at default weighted by the book value of the defaulted bond issue (four−quarter moving average).

Figure 6

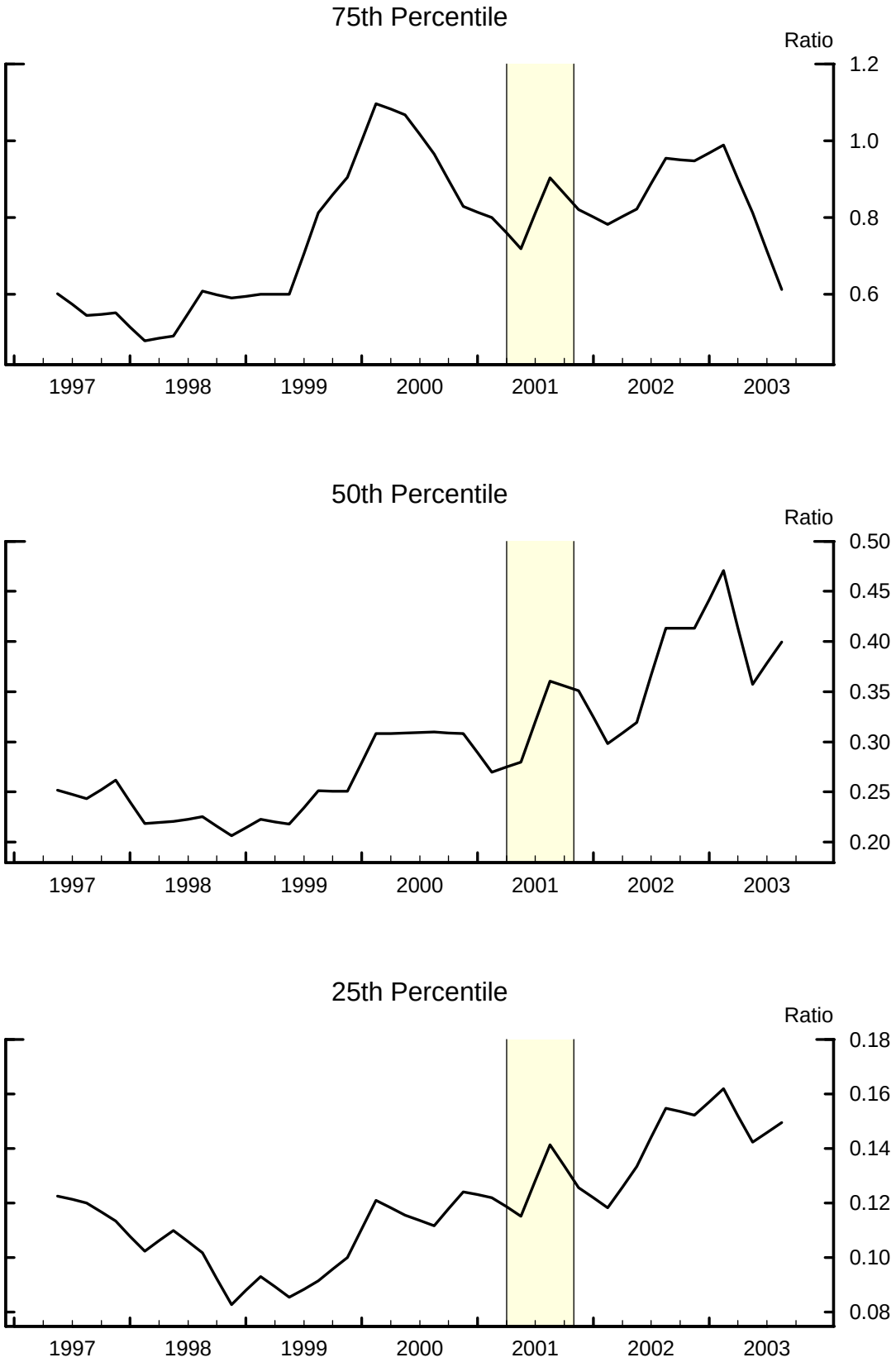
Evolution of Model-Implied External Finance Premium



Note. Percentiles are weighted by real sales.

Figure 7A

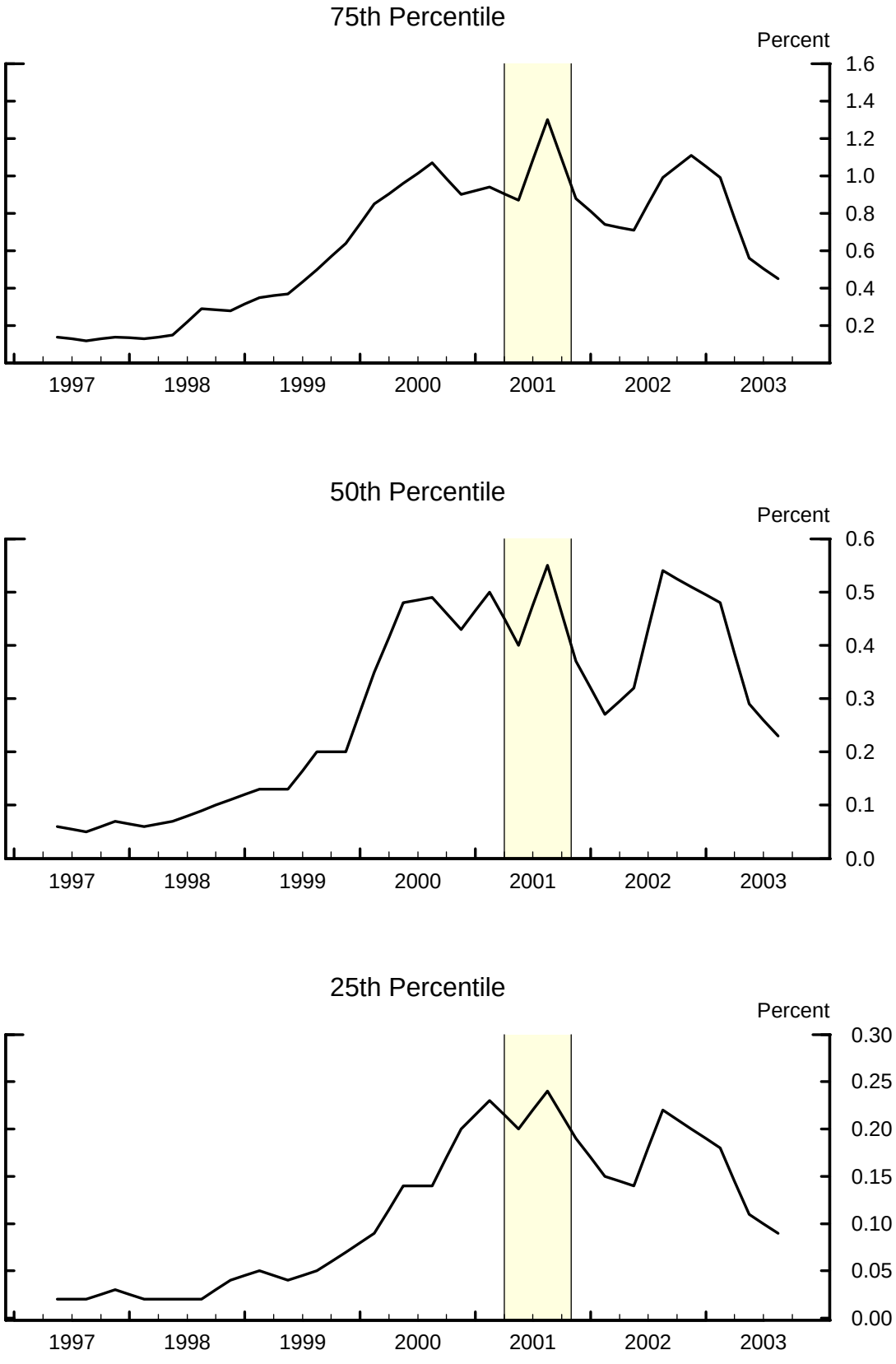
Evolution of Corporate Leverage



Note. Percentiles are weighted by real sales.

Figure 7B

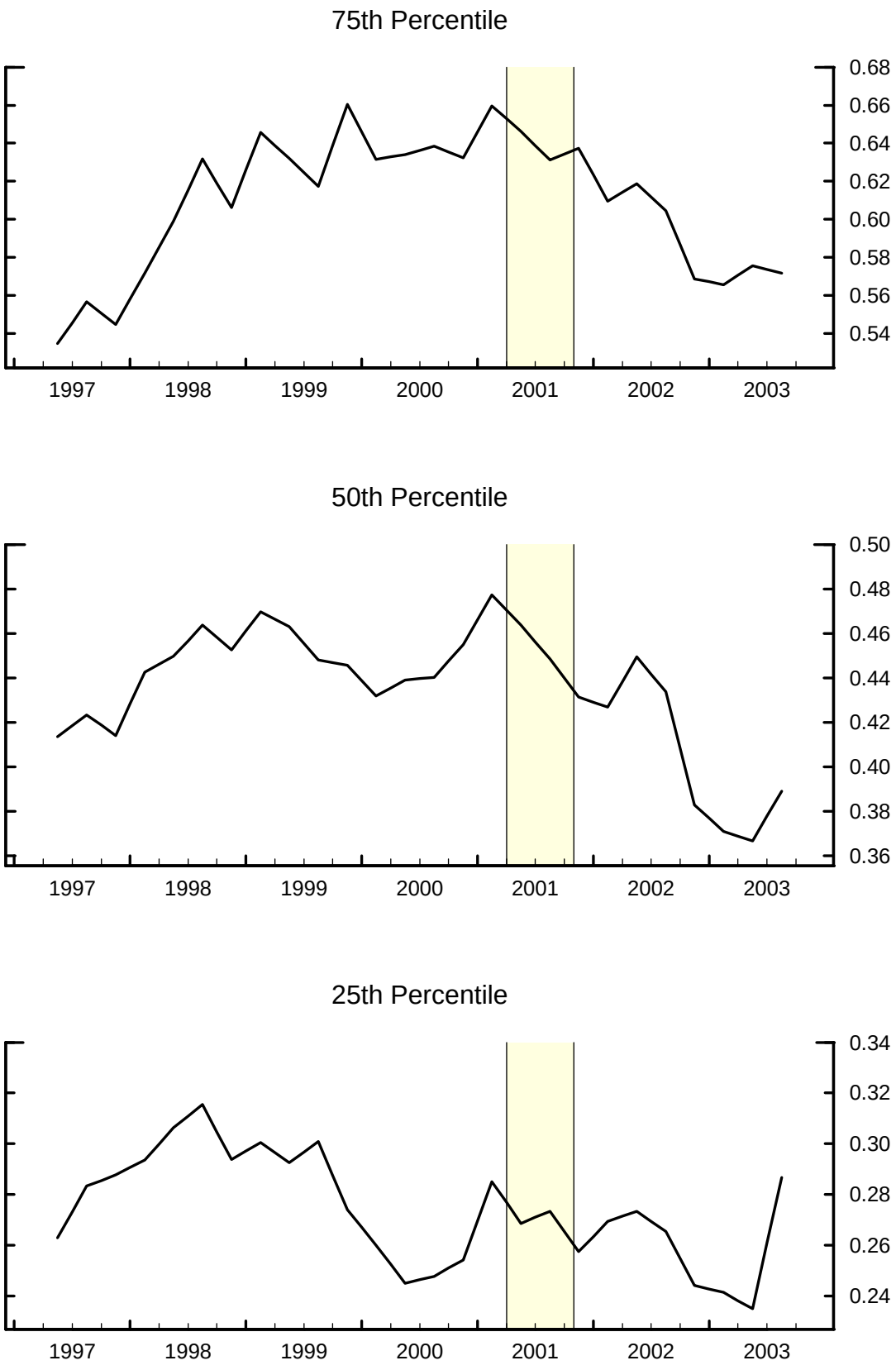
Evolution of Expected Default Probabilities



Note. Percentiles are weighted by real sales.

Figure 7C

Evolution of Model-Implied σ

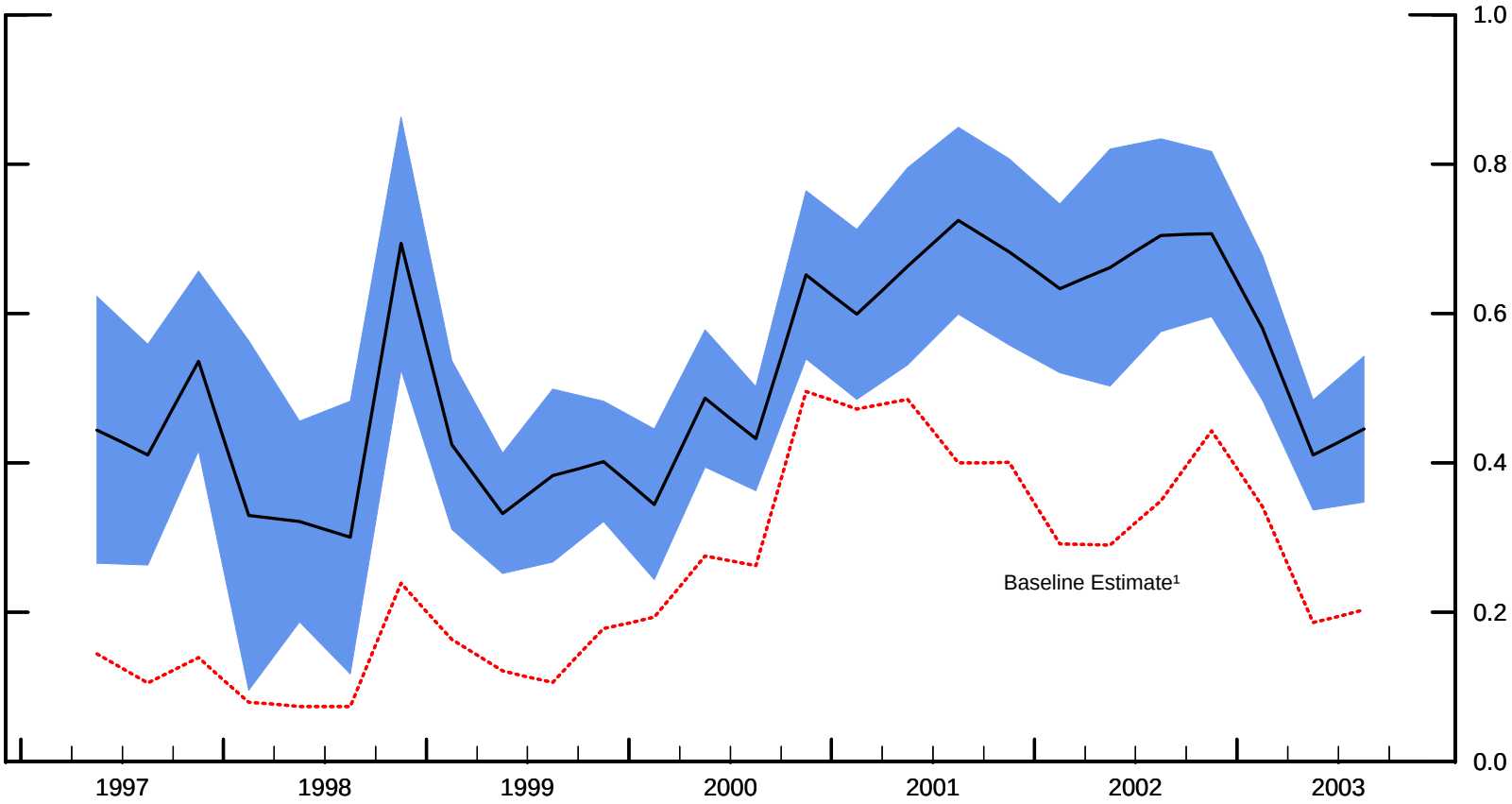


Note. Percentiles are weighted by real sales.

Figure 8A

Implications of Excluding Credit Ratings

NLLS Estimates of the Bankruptcy Cost Parameter μ

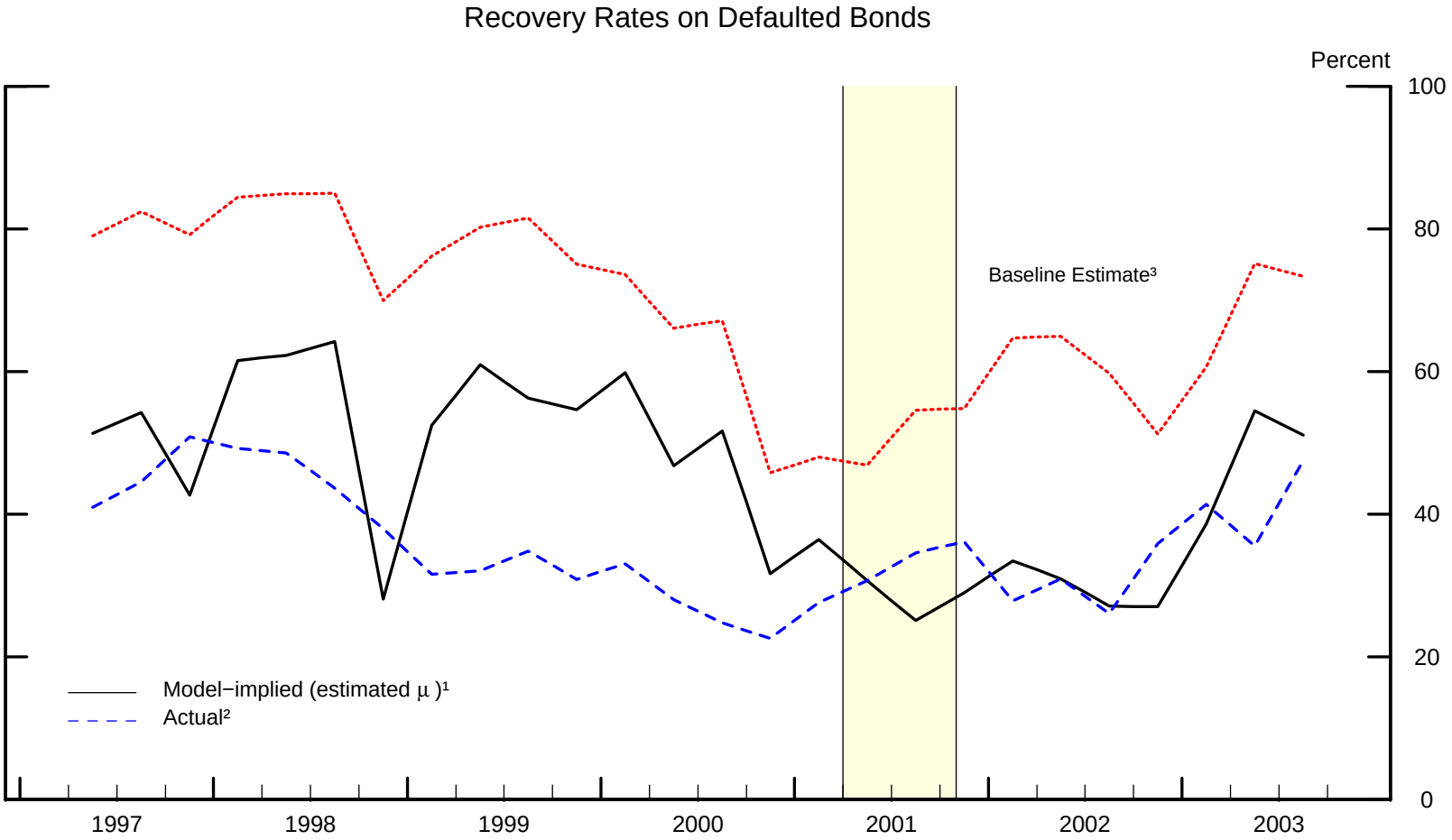


Note. The shaded region represents +/− 2 standard error bands computed using a heteroscedasticity−consistent asymptotic covariance matrix. The model includes fixed industry (3−digit NAICS) effects (see text for details).

¹ See Figure 5.

Figure 8B

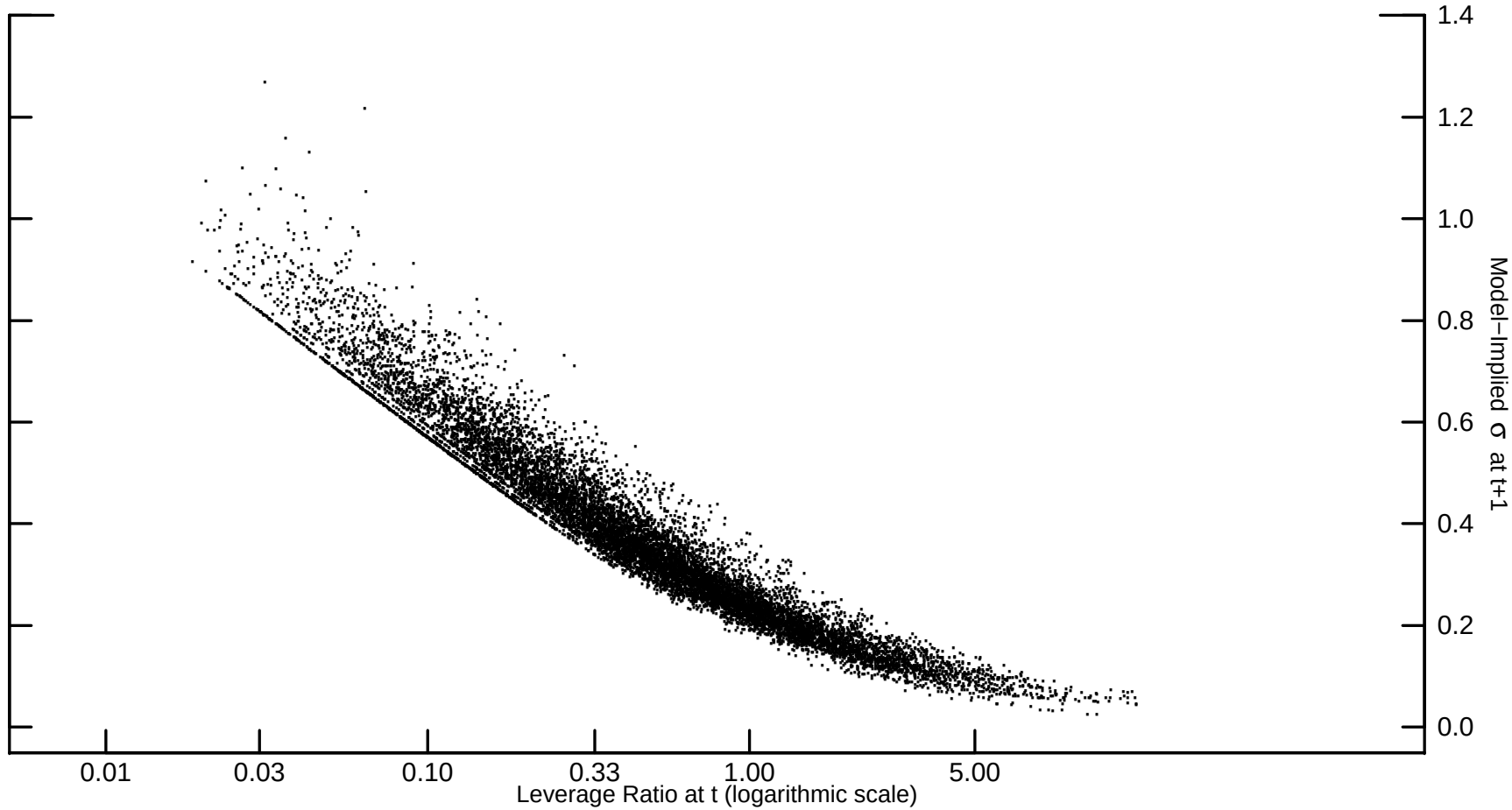
Implications of Excluding Credit Ratings



¹ Average model−implied recovery rate weighted by the book value of bonds outstanding.
² Average recovery rate at default weighted by the book value of the defaulted bond issue (four−quarter moving average).
³ See Figure 6.

Figure 9

Leverage and the Volatility of Idiosyncratic Risk



Directions for Future Research

Address limitations of existing framework:

- allow for *cross-sectional* heterogeneity in μ (e.g., firm size, credit quality, etc.)
- allow for non-Gaussian distribution of idiosyncratic productivity shock ω
- allow for multi-period debt contracts

Directions for Future Research (contd.)

Investigate the link between model-implied external finance premium and capital expenditures.

Examine macroeconomic implications of financial market frictions in light of micro evidence (e.g., the relationship between corporate leverage and financial fragility).

Use perturbation methods to obtain 2nd-order approximation of the DGE model around steady state and characterize optimal monetary policy.

Extend the analysis to open economies.

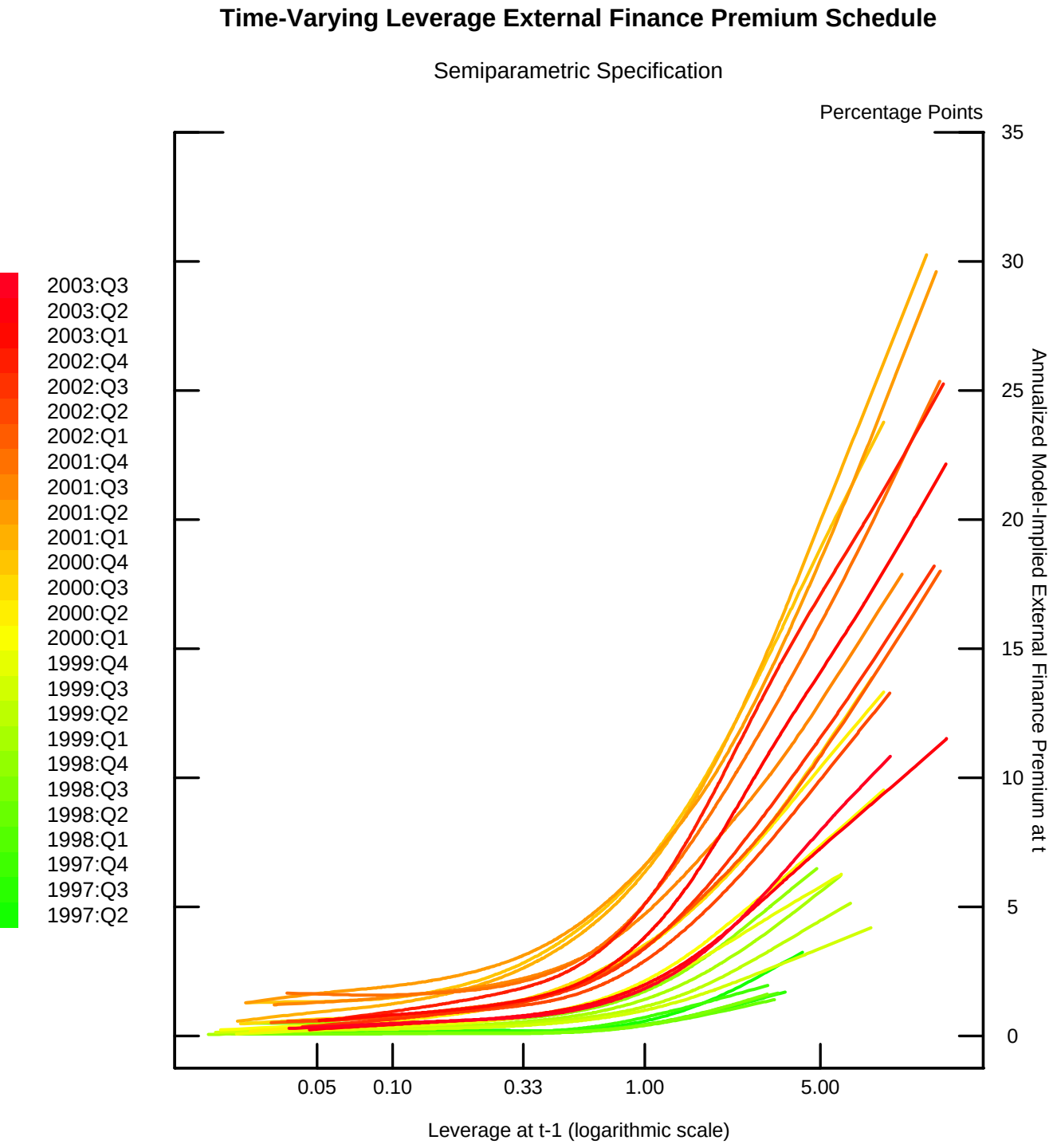
Financial Fragility

Health of corporate balance sheets may be an important state variable in the transmission of shocks to the economy.
(Bernanke & Gertler 1990, Bernanke & Campbell 1998, etc.)

Examine the link between firms' financial condition and model-implied external finance premium over the business cycle:

$$r_{it}^k - r_{it} = \alpha_t + \beta_t \log \mathrm{LEV}_{it-1} + h_t(\log \mathrm{LEV}_{it-1}) + \theta_t' \mathbf{x}_{it-1} + u_{it}$$

- $r_{it}^k - r_{it}$ = model-implied external finance premium
- $h_t(\cdot)$ = "smooth" time-varying function of $\log \mathrm{LEV}_{it-1}$
- $\mathbf{x}_{it-1}$ = control variables (ratings & industry indicators)
- u_{it} = mean-zero error term


Time-Varying Leverage External Finance Premium Schedule
Semiparametric Specification
Percentage Points
35
30
25
20
15
10
5
0
Annualized Model-Implied External Finance Premium at t
2003:Q3
2003:Q2
2003:Q1
2002:Q4
2002:Q3
2002:Q2
2002:Q1
2001:Q4
2001:Q3
2001:Q2
2001:Q1
2000:Q4
2000:Q3
2000:Q2
2000:Q1
1999:Q4
1999:Q3
1999:Q2
1999:Q1
1998:Q4
1998:Q3
1998:Q2
1998:Q1
1997:Q4
1997:Q3
1997:Q2
0.05
0.10
0.33
1.00
5.00
Leverage at t-1 (logarithmic scale)