Credit Spreads and Business Cycle Fluctuations

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Motivation

- Modigliani-Miller [*AER ’58]*: With frictionless financial markets, firms’ capital structure is indeterminate, and the aggregate mix of debt vs. equity is irrelevant for the evolution of the real economy.

- In light of the M-M result, business cycle theory has largely abstracted from incorporating financial factors into models of aggregate fluctuations:
  - IS-LM framework
  - Real business cycle models
  - New Keynesian synthesis
Motivation (cont.)

- Bernanke & Gertler [AER ’89]: Reflecting informational asymmetries between borrowers and lenders, borrowers’ balance sheets can play an important role in the propagation of economic shocks—the financial accelerator.
- Financial accelerator:
  - Informational frictions in credit markets induce a wedge between the cost of external and internal funds—the external finance premium (EFP).
  - Size of the EFP depends inversely on the borrower’s net worth.
  - Declines in equity valuation and/or unexpected deflation reduce borrowers’ net worth.
  - Procyclical net worth leads to countercyclical EFP, enhancing swings in borrowing, investment, and output.
Outline

• Lecture 1: Credit spreads and Economic Activity
  ▶ Credit spreads and leverage in a Costly-State Verification (CSV) framework
  ▶ Empirical evidence on the role of credit spreads in economic activity.

• Lecture 2: Credit Frictions in DSGE Models
  ▶ OLG Example (Bernanke-Gertler)
  ▶ An estimated DSGE model with financial accelerator.
  ▶ Implications for Monetary Policy

• Lecture 3: New Directions:
  ▶ Uncertainty, investment, and business cycle fluctuations.
  ▶ Inflation Dynamics During the Financial Crisis
Entrepreneur’s Investment Opportunity

- Entrepreneur starts period with net worth $N$.
- Entrepreneur borrows:

\[ B = QK - N, \]

- $Q =$ price of capital (exogenous)

- Project payoff:

\[ \omega R^k QK^\alpha, \quad 0 < \alpha < 1 \]

- $R^k =$ aggregate (gross) rate of return on capital (exogenous)
- $\omega =$ idiosyncratic shock to project’s return
- Assume: $\ln \omega \sim N\left(-\frac{\sigma^2}{2}, \sigma^2\right) \Rightarrow E[\omega] = 1$
Information Structure

- No asymmetric information *ex ante*:
  - $R^k$ is known to both lender and entrepreneur before investment decision.
  - $\omega$ is realized after investment decision.

- Asymmetric information *ex post*:
  - $\omega$ is freely observed by entrepreneur.
  - To observe $\omega$, lender must pay
    \[
    \mu \omega R^k Q K^\alpha
    \]
  - Parameter $0 \leq \mu < 1$ measures the cost of monitoring and hence the magnitude of credit market frictions.
Debt Contract

- Entrepreneur and lender agree to a standard debt contract (SDC) that pays lender an amount $D$ as long as bankruptcy does not occur.
- If $\omega R^k Q K^{\alpha} \geq D$:
  - Entrepreneur pays $D$ to lender and keeps residual profits.
- If $\omega R^k Q K^{\alpha} < D$:
  - Entrepreneur declares bankruptcy and gets nothing.
  - Lender pays bankruptcy cost to monitor entrepreneur and keeps profits net of bankruptcy cost.
Payoffs to Entrepreneur and Lender

- Bankruptcy occurs if $\omega \leq \overline{\omega}$:
  \[ \overline{\omega} \equiv \frac{D}{R^k Q K^\alpha} \]

- Expected payoff to entrepreneur:
  \[ \int_{\overline{\omega}}^{\infty} \omega R^k Q K^\alpha d\Phi(\omega) - \overline{\omega} \int_{\overline{\omega}}^{\infty} R^k Q K^\alpha d\Phi(\omega) \]

- Expected payoff to lender:
  \[ (1 - \mu) \int_{0}^{\overline{\omega}} \omega R^k Q K^\alpha d\Phi(\omega) + \overline{\omega} \int_{\overline{\omega}}^{\infty} R^k Q K^\alpha d\Phi(\omega) \]

- Competitive loan market: Lender must earn an expected (gross) rate of return $R$ on the loan amount $B$. 
Payoffs as a Share of Expected Profits ($R^k Q K$)

- Define:

$$\Gamma(\bar{\omega}) \equiv \int_{0}^{\bar{\omega}} \omega d\Phi(\omega) + \bar{\omega} \int_{\bar{\omega}}^{\infty} d\Phi(\omega)$$

$$\mu G(\bar{\omega}) \equiv \mu \int_{0}^{\bar{\omega}} \omega d\Phi(\omega)$$

- Entrepreneur’s expected share of profits:

$$1 - \Gamma(\bar{\omega})$$

- Lender’s expected share of profits:

$$\Gamma(\bar{\omega}) - \mu G(\bar{\omega})$$
Optimal Contract

- Choose $K$ and $\bar{\omega}$ to solve:

$$\max_{K, \bar{\omega}} \left[ 1 - \Gamma(\bar{\omega}) \right] R^k Q K^\alpha$$

subject to the lender’s participation constraint:

$$\left[ \Gamma(\bar{\omega}) - \mu G(\bar{\omega}) \right] R^k Q K^\alpha = R(QK - N)$$

- Lagrangean:

$$\max_{K, \bar{\omega}} \left\{ \left[ (1 - \Gamma(\bar{\omega})) + \lambda (\Gamma(\bar{\omega}) - \mu G(\bar{\omega})) \right] R^k Q K^\alpha - \lambda R(QK - N) \right\}$$

- $\lambda = \text{Lagrange multiplier on the lender’s participation constraint and hence measures the shadow value of an extra unit of net worth to the entrepreneur.}$
- The term in brackets reflects total firm value when valued using the shadow price of external funds.
Optimality Conditions

- FOC w.r.t. $\bar{\omega}$:
  \[ \lambda = \frac{\Gamma'(\bar{\omega})}{[\Gamma'(\bar{\omega}) - \mu G'(\bar{\omega})]} \geq 1 \]

- FOC w.r.t. $K$:
  \[ \alpha [(1 - \Gamma(\bar{\omega})) + \lambda (\Gamma(\bar{\omega}) - \mu G(\bar{\omega}))] R^k Q K^{\alpha-1} = \lambda R Q \]

- FOC w.r.t. $\lambda$:
  \[ [\Gamma(\bar{\omega}) - \mu G(\bar{\omega})] R^k Q K^{\alpha} = R(Q K - N) \]
External Finance Premium

- FOCs imply:
  \[ \alpha R^k Q K^{\alpha - 1} = \rho(\bar{\omega}) R Q \]

  \[ \rho(\bar{\omega}) = \left[ \frac{\lambda}{1 - \Gamma(\bar{\omega})} + \lambda \left[ \Gamma(\bar{\omega}) - \mu G(\bar{\omega}) \right] \right] \geq 1 \]

  \[ \rho(\bar{\omega}) = \text{external finance premium (EFP)} \]

- EFP is increasing in the default barrier \( \bar{\omega} \):
  \[ \rho'(\bar{\omega}) > 1 \]
Leverage and Default:

- The default barrier $\bar{\omega}$ is increasing in leverage:

$$\frac{QK}{N} = \frac{\psi(\bar{\omega})}{1 - (1 - \alpha)\psi(\bar{\omega})}$$

where

$$\psi(\bar{\omega}) = \left[ 1 + \frac{\lambda [\Gamma(\bar{\omega}) - \mu G(\bar{\omega})]}{1 - \Gamma(\bar{\omega})} \right] \geq 1$$

$$\psi'(\bar{\omega}) > 0$$

- Intuition:
  - An increase in leverage requires a higher default barrier to increase the payoff to the lender relative to the entrepreneur.
  - The increase in the default barrier also implies a higher shadow value of external funds $\lambda$.
  - An increase in net worth reduces the default barrier and lowers the premium on external funds.
Example: Constant Returns to Scale ($\alpha = 1$)

- The default barrier is determined by the rate of return on capital relative to the risk-free rate of return:

$$\frac{R^k}{R} = \rho(\bar{\omega})$$

- Given $\bar{\omega}$, capital expenditures are determined by available net worth:

$$\frac{QK}{N} = \psi(\bar{\omega})$$

- Combining these, we obtain a positive relationship between the premium on external funds and leverage:

$$\frac{R^k}{R} = s\left(\frac{QK}{N}\right), \quad s' > 0$$
Implications of Changes in Monitoring Costs $\mu$

$\sigma = 0.28$

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**External Finance Premium**

- Percentage Points
- $\mu = 0$
- $\mu = 0.12$
- $\mu = 0.24$
- $\mu = 0.36$

**Default Productivity Threshold**

- Leverage (logarithmic scale)
- Probability of Default
- Credit Spread

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CSV Model

Gilchrist, Yankov & Zakrajšek (2009)

Gilchrist and Zakrajsek (2012)

BMA Forecasting: FGWZ (2012)
Financial markets are forward looking:
- Asset prices should impound information about investors’ expectations of future economic outcomes
- Extracting that information may be complicated by the presence of time-varying risk premia

Research on the role of asset prices in cyclical fluctuations stresses the predictive content of default-risk indicators. (Friedman & Kuttner [1992,1998]; Gertler & Lown [1999]; Mueller [2007])
### Asset Prices and Economic Activity

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  - Extracting that information may be complicated by the presence of time-varying risk premia

- Research on the role of asset prices in cyclical fluctuations stresses the predictive content of default-risk indicators.
  
  (Friedman & Kuttner [1992,1998]; Gertler & Lown [1999]; Mueller [2007])
GYZ (2009): Methodology

- Use **security-level** data to construct **bond portfolios** that assign each bond outstanding to a category determined by:
  - Firm-specific expected probability of default (EDF).
  - Bond-specific remaining term-to-maturity.
- Use CRSP equity returns to construct matched **equity portfolios**.
Forecasting Framework

- Measures of economic activity:
  - EP: log of private nonfarm payroll employment
  - IP: log of industrial production

- Forecasting VAR specification:

\[
\Delta^{h} EP_{t+h} = \beta_1(L) \Delta EP_t + \beta_2(L) \Delta IP_t + \eta_1' Z_{1t} + \eta_2' Z_{2t} + \epsilon_{1,t+h}
\]

\[
\Delta^{h} IP_{t+h} = \gamma_1(L) \Delta EP_t + \gamma_2(L) \Delta IP_t + \theta_1' Z_{1t} + \theta_2' Z_{2t} + \epsilon_{2,t+h}
\]

- \( Z_{1t} \) = standard default-risk indicators
  (CP-bill spread, Aaa, Baa, HY spread)
- \( Z_{2t} \) = EDF-based portfolio credit spreads
# In-Sample Predictive Power

*(Sample period: Feb1990–Sep2008; 12-month forecast horizon)*

<table>
<thead>
<tr>
<th>Credit Spreads</th>
<th>Pr &gt; $W_1$</th>
<th>Pr &gt; $W_2$</th>
<th>Adj. $R^2$</th>
<th>Pr &gt; $W_1$</th>
<th>Pr &gt; $W_2$</th>
<th>Adj. $R^2$</th>
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</thead>
<tbody>
<tr>
<td>Standard</td>
<td>0.003</td>
<td>-</td>
<td>0.665</td>
<td>0.109</td>
<td>-</td>
<td>0.200</td>
</tr>
<tr>
<td>EDF-Q1</td>
<td>-</td>
<td>0.000</td>
<td>0.727</td>
<td>-</td>
<td>0.000</td>
<td>0.563</td>
</tr>
<tr>
<td>EDF-Q2</td>
<td>-</td>
<td>0.000</td>
<td>0.759</td>
<td>-</td>
<td>0.000</td>
<td>0.641</td>
</tr>
<tr>
<td>EDF-Q3</td>
<td>-</td>
<td>0.000</td>
<td>0.739</td>
<td>-</td>
<td>0.000</td>
<td>0.528</td>
</tr>
<tr>
<td>EDF-Q4</td>
<td>-</td>
<td>0.000</td>
<td>0.704</td>
<td>-</td>
<td>0.000</td>
<td>0.439</td>
</tr>
<tr>
<td>EDF-Q5</td>
<td>-</td>
<td>0.000</td>
<td>0.685</td>
<td>-</td>
<td>0.000</td>
<td>0.420</td>
</tr>
<tr>
<td>Standard &amp; EDF-Q1</td>
<td>0.000</td>
<td>0.000</td>
<td>0.809</td>
<td>0.297</td>
<td>0.000</td>
<td>0.585</td>
</tr>
<tr>
<td>Standard &amp; EDF-Q2</td>
<td>0.016</td>
<td>0.000</td>
<td>0.817</td>
<td>0.128</td>
<td>0.000</td>
<td>0.679</td>
</tr>
<tr>
<td>Standard &amp; EDF-Q3</td>
<td>0.000</td>
<td>0.000</td>
<td>0.816</td>
<td>0.000</td>
<td>0.000</td>
<td>0.645</td>
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<tr>
<td>Standard &amp; EDF-Q4</td>
<td>0.000</td>
<td>0.000</td>
<td>0.795</td>
<td>0.021</td>
<td>0.000</td>
<td>0.552</td>
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<tr>
<td>Standard &amp; EDF-Q5</td>
<td>0.000</td>
<td>0.000</td>
<td>0.791</td>
<td>0.015</td>
<td>0.000</td>
<td>0.500</td>
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<tr>
<td><strong>Memo:</strong> None</td>
<td>-</td>
<td>-</td>
<td>0.537</td>
<td>-</td>
<td>-</td>
<td>0.042</td>
</tr>
</tbody>
</table>
# Out-of-Sample Predictive Power

*(Sample period: Feb1990–Sep2008; 12-month forecast horizon)*

<table>
<thead>
<tr>
<th>Credit Spreads</th>
<th>Nonfarm Employment (EP)</th>
<th></th>
<th></th>
<th>Industrial Production (IP)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RMSFE</td>
<td>Ratio</td>
<td>Pr &gt;</td>
<td>S</td>
<td></td>
<td>RMSFE</td>
</tr>
<tr>
<td>Standard</td>
<td>1.113</td>
<td>-</td>
<td>-</td>
<td>3.676</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>EDF-Q1</td>
<td>0.693</td>
<td>0.387</td>
<td>0.002</td>
<td>2.087</td>
<td>0.323</td>
<td>0.000</td>
</tr>
<tr>
<td>EDF-Q2</td>
<td>0.667</td>
<td>0.359</td>
<td>0.001</td>
<td>2.004</td>
<td>0.297</td>
<td>0.000</td>
</tr>
<tr>
<td>EDF-Q3</td>
<td>0.740</td>
<td>0.442</td>
<td>0.000</td>
<td>2.279</td>
<td>0.384</td>
<td>0.000</td>
</tr>
<tr>
<td>EDF-Q4</td>
<td>0.902</td>
<td>0.659</td>
<td>0.094</td>
<td>2.704</td>
<td>0.541</td>
<td>0.004</td>
</tr>
<tr>
<td>EDF-Q5</td>
<td>0.872</td>
<td>0.613</td>
<td>0.092</td>
<td>2.574</td>
<td>0.490</td>
<td>0.001</td>
</tr>
<tr>
<td>Standard &amp; EDF-Q1</td>
<td>0.827</td>
<td>0.551</td>
<td>-</td>
<td>2.571</td>
<td>0.489</td>
<td>-</td>
</tr>
<tr>
<td>Standard &amp; EDF-Q2</td>
<td>0.816</td>
<td>0.537</td>
<td>-</td>
<td>2.238</td>
<td>0.371</td>
<td>-</td>
</tr>
<tr>
<td>Standard &amp; EDF-Q3</td>
<td>0.814</td>
<td>0.535</td>
<td>-</td>
<td>2.376</td>
<td>0.418</td>
<td>-</td>
</tr>
<tr>
<td>Standard &amp; EDF-Q4</td>
<td>0.869</td>
<td>0.609</td>
<td>-</td>
<td>2.686</td>
<td>0.539</td>
<td>-</td>
</tr>
<tr>
<td>Standard &amp; EDF-Q5</td>
<td>0.864</td>
<td>0.602</td>
<td>-</td>
<td>2.948</td>
<td>0.643</td>
<td>-</td>
</tr>
</tbody>
</table>

*Memo: None* 1.115             -     -     3.882             -     -
Structural Factor Model (FAVAR)

- Use a structural factor model to identify a credit market shock.
- FAVAR specification:
  - State-space equation:
    \[
    \begin{bmatrix}
    F_{1t} \\
    F_{2t}
    \end{bmatrix} = \Phi(L) \begin{bmatrix}
    F_{1,t-1} \\
    F_{2,t-1}
    \end{bmatrix} + \begin{bmatrix}
    \epsilon_{1t} \\
    \epsilon_{2t}
    \end{bmatrix}
    \]
  - Observation equation:
    \[
    \begin{bmatrix}
    X_{1t} \\
    X_{2t}
    \end{bmatrix} = \begin{bmatrix}
    \Lambda_{11} & \Lambda_{21} \\
    \Lambda_{21} & \Lambda_{22}
    \end{bmatrix} \begin{bmatrix}
    F'_{1t} \\
    F'_{2t}
    \end{bmatrix} + \begin{bmatrix}
    \nu_{1t} \\
    \nu_{2t}
    \end{bmatrix}
    \]
Estimation and Identification

- Observable variables and factors can be divided into 2 groups:
  - **Group 1:** variables $(X_{1t})$ and factors $(F_{1t})$ related to the real, nominal, and the financial side of the economy
  - **Group 2:** variables $(X_{2t})$ and factors $(F_{2t})$ pertaining to the corporate bond market
4-step Estimation Procedure:

- Extract $F_{1t}$ as the first $k_1$ principle components of $X_{1t}$
- Regress $X_{2t}$ on $F_{1t}$ and take the residuals $\hat{E}_t$
- Extract $F_2$ as the first $k_2$ principle components of $\hat{E}_t$
- Estimate matrices of factor loadings ($\Lambda_{11}, \Lambda_{21}, \Lambda_{22}$) from the measurement equation by regression (imposing the restriction that $\Lambda_{12} = 0$)
Identifying credit market shocks:

- Impose identification on factor model.
- Recursive identification scheme: $F_{2t}$ orthogonal to $F_{1t}$
- This is equivalent to ordering $F_{2t}$ last in the Cholesky decomposition of $\Sigma_\epsilon = E(\epsilon\epsilon')$
Specification

- Group 1 variables ($X_{1t}$):
  - **Economic Activity** (11): unemployment rate, employment growth; industrial production; durable and nondurable goods orders, consumer spending, etc.
  - **Inflation Indicators** (6): CPI, core CPI, PPI, core PPI, commodity and oil prices (WTI)
  - **Real Interest Rates** (7): funds rate, Treasury yields (6-month, 1-year, . . . , 10-year)
  - **Financial Asset Indicators** (12): excess market return, excess equity returns by EDF quintile, Fama-French factors (HML, SMB) option-implied volatilities on equity prices and short- and long-term interest rates, foreign exchange value of the dollar

- Group 2 variables ($X_{2t}$):
  - EDF-based portfolios of credit spreads (20)

- Baseline specification: $k_1 = 4$, $k_2 = 2$, $p = 6$. 
Macroeconomic and Financial Factors

Factor 1

Factor 2

Factor 3

Factor 4
Credit Factors

Factor 1

Factor 2

Std. deviations

NBER Peak


-0.3

-0.2

-0.1

0.0

0.1

0.2

0.3

-0.3

-0.2

-0.1

0.0

0.1

0.2

0.3

-0.3
Response of Corporate Bond Spreads

Short maturity credit spreads by EDF quintile*
- Percentage points
- Months after shock

Intermediate maturity credit spreads by EDF quintile*
- Percentage points
- Months after shock

Long maturity credit spreads by EDF quintile*
- Percentage points
- Months after shock

Very long maturity credit spreads by EDF quintile*
- Percentage points
- Months after shock

* Bonds with term to maturity under 3 years.
* Bonds with term to maturity 3–7 years.
* Bonds with term to maturity 7–15 years.
* Bonds with term to maturity above 15 years.
Response of Selected Variables

- Industrial production
- Core CPI
- Real federal funds rate
- Real 10-year Treasury yield
- Cumulative excess stock market return
- S&P 500 implied volatility (VIX)
- Cumulative excess stock return EDF Quintile 1
- Cumulative excess stock return EDF Quintile 5
Forecast Error Variance Decomposition

- Industrial production
- Core CPI
- Real federal funds rate
- Real 10-year Treasury yield
- Cumulative excess stock market return
- S&P 500 implied volatility (VIX)
- Cumulative excess stock return EDF Quintile 1
- Cumulative excess stock return EDF Quintile 5
Summary of Results

- Predictive content of credit spreads is concentrated in long-maturity corporate bonds issued by medium-risk firms.
- Shocks to medium-risk, long-maturity credit spreads account for a significant fraction of the variance in economic activity at 1–2 year horizon over the 1990–2008 period.
Credit Spreads and Economic Fluctuations

- Predictive content could reflect disruption in the supply of credit stemming from:
  - Worsening of the quality of borrowers’ balance sheets
    (Kiyotaki & Moore [1997]; Bernanke, Gertler & Gilchrist [1999]; Hall [2010])
  - Deterioration in the health of financial intermediaries
    (Gertler & Karadi [2009]; Gertler & Kiyotaki [2009])

- Predictive content could reflect the ability of the corporate bond market to signal more accurately than the stock market a decline in economic fundamentals.
  (Philippon [2009])
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  (Philippon [2009])
• Re-examine the evidence on the relationship between credit spreads and economic activity over the 1973–2010 period.

• Use prices of individual securities to construct a credit spread with a high information content for future economic activity.

• Decompose the predictive content of credit spread into:
  ▶ Component capturing countercyclical movements in expected defaults
  ▶ Component—the excess bond premium (EBP)—representing cyclical changes in the relationship between expected default risk and credit spreads

• Decomposition motivated in part by the “credit spread puzzle.”
  (Elton et al. [2009]; Collin-Dufresne et al. [2001]; Driessen [2005])
Gilchrist and Zakrajsek (2012)

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Main Findings

• Predictive content of credit spreads for economic activity is almost entirely due to movements in the EBP.

• Unanticipated increases in the EBP:
  ▶ Lead to significant and protracted declines in economic activity and the stock market
  ▶ Account for a substantial fraction of the variation in real activity and stock market at business cycle frequencies
**Main Findings**

- Predictive content of credit spreads for economic activity is almost entirely due to movements in the EBP.
- Unanticipated increases in the EBP:
  - Lead to significant and protracted declines in economic activity and the stock market
  - Account for a substantial fraction of the variation in real activity and stock market at business cycle frequencies
Bond-Level Data

- CRSP/Compustat panel of U.S. nonfinancial firms matched with prices of outstanding corporate bonds traded in the secondary market.

- Lehman/Warga & Merrill Lynch issue-level data:
  - Sample period: Jan1973–Jun2010 (month-end)
  - 1,116 U.S. nonfinancial issuers
  - 5,942 senior unsecured (fixed-coupon) bond issues
  - 338,615 observations
  - Information: price, issue date, maturity, coupon, issue size, etc.
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CONSTRUCTING CREDIT SPREADS

- Construct a risk-free security that replicates the cash-flows of the corporate debt instrument.
- Price of a bond with cash-flows: \( \{c(s): s = 1, 2, \ldots, S\} \)

\[
P_t = \sum_{s=1}^{S} c(s)D(t_s), \quad D(t) = e^{-r_t t}
\]

- \( P_t^f \) = price of a corresponding risk-free security
  - Cash-flows discounted using continuously-compounded zero-coupon Treasury yields in period \( t \)

- Credit spread: \( S_{it}[k] = y_{it}[k] - y_t^f[k] \)
  - \( y_{it}[k] = \text{YTM of corporate bond } k \) (issued by firm \( i \))
  - \( y_t^f[k] = \text{YTM of the corresponding risk-free bond} \)
CONSTRUCTING CREDIT SPREADS

• Construct a risk-free security that replicates the cash-flows of the corporate debt instrument.

• Price of a bond with cash-flows: \( \{c(s): s = 1, 2, \ldots, S\} \)

\[
P_t = \sum_{s=1}^{S} c(s)D(t_s), \quad D(t) = e^{-r_t t}
\]

• \( P_t^f \) = price of a corresponding risk-free security
  ▶ Cash-flows discounted using continuously-compounded zero-coupon Treasury yields in period \( t \)

• Credit spread: \( S_{it}[k] = y_{it}[k] - y_t^f[k] \)
  ▶ \( y_{it}[k] \) = YTM of corporate bond \( k \) (issued by firm \( i \))
  ▶ \( y_t^f[k] \) = YTM of the corresponding risk-free bond
**Constructing Credit Spreads**

- Construct a risk-free security that replicates the cash-flows of the corporate debt instrument.
- Price of a bond with cash-flows: \( \{c(s): s = 1, 2, \ldots, S\} \)

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**SUMMARY STATISTICS OF BOND CHARACTERISTICS**

(Jan1973–Jun2010)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>Min</th>
<th>P50</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of bonds per firm/month</td>
<td>2.89</td>
<td>3.54</td>
<td>1.00</td>
<td>2.00</td>
<td>74.0</td>
</tr>
<tr>
<td>Mkt. value of issue ($mil.)</td>
<td>317.9</td>
<td>319.7</td>
<td>1.22</td>
<td>236.1</td>
<td>5,628</td>
</tr>
<tr>
<td>Maturity at issue (years)</td>
<td>13.0</td>
<td>9.3</td>
<td>1.0</td>
<td>10.0</td>
<td>50.0</td>
</tr>
<tr>
<td>Term to maturity (years)</td>
<td>11.3</td>
<td>8.5</td>
<td>1.0</td>
<td>8.2</td>
<td>30.0</td>
</tr>
<tr>
<td>Duration (years)</td>
<td>6.48</td>
<td>3.19</td>
<td>0.91</td>
<td>6.08</td>
<td>15.8</td>
</tr>
<tr>
<td>Credit rating (S&amp;P)</td>
<td>-</td>
<td>-</td>
<td>D</td>
<td>BBB1</td>
<td>AAA</td>
</tr>
<tr>
<td>Coupon rate (pct.)</td>
<td>7.32</td>
<td>2.00</td>
<td>1.70</td>
<td>7.00</td>
<td>17.5</td>
</tr>
<tr>
<td>Nominal effective yield (pct.)</td>
<td>7.73</td>
<td>3.23</td>
<td>0.60</td>
<td>7.19</td>
<td>44.3</td>
</tr>
<tr>
<td>Credit spread (bps.)</td>
<td>203</td>
<td>281</td>
<td>5</td>
<td>116</td>
<td>3,499</td>
</tr>
</tbody>
</table>

- **GZ spread**: cross-sectional average of credit spreads in period $t$

\[ S_{t}^{GZ} = \frac{1}{N_{t}} \sum_{i} \sum_{k} S_{it}[k] \]
## Summary Statistics of Bond Characteristics

(Jan1973–Jun2010)

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<td>3,499</td>
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</tbody>
</table>

- **GZ spread**: cross-sectional average of credit spreads in period $t$

\[
S_t^{GZ} = \frac{1}{N_t} \sum_i \sum_k S_{it}[k]
\]
SELECTED CORPORATE CREDIT SPREADS

(Jan1973–Jun2010)
Predictive Content of Credit Spreads

- Forecasting specification ($h$-periods ahead):

$$ \nabla^h Y_{t+h} = \alpha + \sum_{i=0}^{p} \beta_i \nabla Y_{t-i} + \gamma_1 TS_t + \gamma_2 RFF_t + \gamma_3 CS_t + \epsilon_{t+h} $$

  - $\nabla^h Y_{t+h} \equiv \frac{c}{h} \ln \left( \frac{Y_{t+h}}{Y_t} \right)$, where (c = 400/1, 200)
  - $Y_t$ = measure of economic activity
  - $TS_t$ = term spread (Treas3mo − Treas10yr)
  - $RFF_t$ = real federal funds rate (nominal FFR − core PCE infl.)
  - $CS_t$ = credit spread (paper-bill, Baa-Aaa, GZ)

- Estimated by OLS w/ Hodrick (1992) SEs.
# Economic Indicator: Payroll Employment

(Sample period: Jan1973–Jun2010)

<table>
<thead>
<tr>
<th>Financial Indicator</th>
<th>Forecast Horizon: 3 months</th>
<th>Forecast Horizon: 12 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Term spread</td>
<td>-0.082 -0.087 -0.086 -0.099</td>
<td>-0.238 -0.239 -0.219 -0.267</td>
</tr>
<tr>
<td></td>
<td>[1.94] [2.05] [2.06] [2.39]</td>
<td>[4.82] [4.79] [4.71] [5.54]</td>
</tr>
<tr>
<td>Real FFR</td>
<td>-0.083 -0.011 -0.077 -0.132</td>
<td>-0.125 -0.111 -0.157 -0.208</td>
</tr>
<tr>
<td></td>
<td>[1.82] [0.18] [1.67] [2.84]</td>
<td>[2.38] [1.75] [3.15] [4.09]</td>
</tr>
<tr>
<td>CP-bill spread</td>
<td>-0.108 -          -          -0.022 -</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[2.40]</td>
<td>[0.64]</td>
</tr>
<tr>
<td>Baa–Aaa spread</td>
<td>-          -0.020 -         0.111 -</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[0.52]</td>
<td>[2.31]</td>
</tr>
<tr>
<td>GZ spread</td>
<td>-          -          -0.272 -</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[6.61]</td>
<td>[12.4]</td>
</tr>
<tr>
<td>Adj. $R^2$</td>
<td>0.661 0.667 0.660 0.705</td>
<td>0.448 0.447 0.456 0.577</td>
</tr>
</tbody>
</table>

**NOTE:** Parameter estimates are standardized; absolute $t$-statistics in brackets.
## Economic Indicator: Real GDP

*(Sample period: 1973:Q1–2010:Q2)*

<table>
<thead>
<tr>
<th>Financial Indicator</th>
<th>Forecast Horizon: 1 quarter</th>
<th>Forecast Horizon: 4 quarters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Term spread</td>
<td>-0.143 1.38</td>
<td>-0.175 1.63</td>
</tr>
<tr>
<td>Real FFR</td>
<td>-0.103 0.97</td>
<td>0.110 0.76</td>
</tr>
<tr>
<td>CP-bill spread</td>
<td>-   2.33</td>
<td>-0.254</td>
</tr>
<tr>
<td>Baa–Aaa spread</td>
<td>-   0.51</td>
<td>-0.059</td>
</tr>
<tr>
<td>GZ spread</td>
<td>-   3.98</td>
<td>-</td>
</tr>
<tr>
<td>Adj. R²</td>
<td>0.176 3.98</td>
<td>0.191</td>
</tr>
</tbody>
</table>

**Note:** Parameter estimates are standardized; absolute t-statistics in brackets.


**FRAMEWORK**

- **Empirical bond-pricing model:**

  \[
  \ln S_{it}[k] = \beta_0 + \beta_1 DFT_{it} + \beta_2 Z_{it}[k] + \epsilon_{it}[k]
  \]

  - \( S_{it}[k] \) = credit spread on bond \( k \) (issued by firm \( i \))
  - \( DFT_{it} \) = measure of expected default risk for firm \( i \)
  - \( Z_{it}[k] \) = bond-specific control variables
  - \( \epsilon_{it}[k] \) = “pricing error”

- **Estimated by OLS w/ two-way clustered SEs.**
Credit Spread Decomposition

- Predicted level of the spread for bond $k$:

$$\hat{S}_{it}[k] = \hat{\theta} \tilde{S}_{it}[k]$$

  $\tilde{S}_{it}[k] = \exp(\hat{\beta}_0 + \hat{\beta}_1 DFT_{it} + \hat{\beta}'_3 Z_{it})$

  $\hat{\theta}$ obtained from pooled regression: $S_{it}[k] = \theta \tilde{S}_{it}[k] + \nu_{it}[k]$

- Predicted GZ spread:

$$\hat{S}_{GZ}^t = \frac{1}{N_t} \sum_i \sum_k \hat{S}_{it}[k]$$

- The excess bond premium:

$$EBP_t = S_{GZ}^t - \hat{S}_{GZ}^t$$
Credit Spread Decomposition

- Predicted level of the spread for bond $k$:

$$\hat{S}_{it}[k] = \hat{\theta}\tilde{S}_{it}[k]$$

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$$\hat{S}_{GZ}^t = \frac{1}{N_t} \sum_i \sum_k \hat{S}_{it}[k]$$

- The excess bond premium:

$$EBP_t = S_{GZ}^t - \hat{S}_{GZ}^t$$
Merton distance-to-default (DD) model:

- Value of the firm \( V \) follows a geometric Brownian motion

\[
dV = \mu_V V \, dt + \sigma_V V \, dW
\]

- Firm has just issued a discount bond \( D \) maturing in \( T \) periods

Distance-to-default (1-year horizon):

\[
DD = \frac{\ln(V/D) + (\mu_V - 0.5\sigma_V^2)}{\sigma_V}
\]

- \( V, \mu_V, \sigma_V \) estimated using data on \( E, D, \mu_E, \sigma_E \) (Bharath & Shumway [2008])

- Sample: U.S. nonfinancial corporate sector (\( \approx 11,000 \) firms)
Default Risk

- Merton distance-to-default (DD) model:
  - Value of the firm ($V$) follows a geometric Brownian motion
    \[ dV = \mu_V V dt + \sigma_V V dW \]
  - Firm has just issued a discount bond ($D$) maturing in $T$ periods

- Distance-to-default (1-year horizon):
  \[ DD = \frac{\ln(V/D) + (\mu_V - 0.5\sigma_V^2)}{\sigma_V} \]
  - $V, \mu_V, \sigma_V$ estimated using data on $E, D, \mu_E, \sigma_E$
    (Bharath & Shumway [2008])

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**Default Risk**

- **Merton distance-to-default (DD) model:**
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- **Sample:** U.S. nonfinancial corporate sector (\( \approx 11,000 \) firms)
Distance to Default

(Jan1973–Jun2010)

Monthly

Nonfinancial corporate sector (median)
Median
Interquartile range

STD. deviations

0 4 8 12 16 20


STD. deviations

0 4 8 12 16 20

Distance to Default and Actual Default Rate

(Jan1981–Sep2010)
### Comparing Measures of Default Risk

(Sample period: Feb1990–Jun2010)

#### EDF Specification

| $EDF_{it}$ | 0.098 (0.006) | 0.094 (0.005) | 0.060 (0.004) | 0.157 (0.010) |
| $EDF_{it}^2$ | - | - | - | -0.004 (0.000) |

| Adj. $R^2$ | 0.396 | 0.437 | 0.631 | 0.648 |
| Industry Effects | - | 0.000 | 0.000 | 0.000 |
| Credit Rating Effects | - | - | 0.000 | 0.000 |

#### DD Specification

| $-DD_{it}$ | 0.127 (0.005) | 0.124 (0.005) | 0.084 (0.005) | 0.197 (0.011) |
| $(−DD_{it})^2$ | - | - | - | 0.007 (0.001) |

| Adj. $R^2$ | 0.522 | 0.546 | 0.686 | 0.710 |
| Industry Effects | - | 0.000 | 0.000 | 0.000 |
| Credit Rating Effects | - | - | 0.000 | 0.000 |

**Note:** Standard errors in parentheses.
CALLABLE CORPORATE DEBT

(Jan 1973–Jun 2010)
Option-Adjusted Excess Bond Premium

- Movements in risk-free rates—by changing the value of embedded call options—have an independent effect on prices of callable bonds. (Duffee [1998])
- Prices of callable bonds are more sensitive to uncertainty regarding the future course of interest rates.
- Option-adjusted EBP:
  - Include call-option indicator in the bond-pricing regression
  - Spreads on callable bonds are allowed to depend on the level, slope, and curvature factors, as well as on interest rate volatility
**Option-Adjusted Excess Bond Premium**

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  *(Duffee [1998]*)

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**OPTION-ADJUSTED EXCESS BOND PREMIUM**

- Movements in risk-free rates—by changing the value of embedded call options—have an independent effect on prices of callable bonds. ([Duffee [1998]](Duffee%20[1998]))

- Prices of callable bonds are more sensitive to uncertainty regarding the future course of interest rates.

- **Option-adjusted EBP:**
  - Include call-option indicator in the bond-pricing regression
  - Spreads on callable bonds are allowed to depend on the level, slope, and curvature factors, as well as on interest rate volatility
## SELECTED MARGINAL EFFECTS BY TYPE OF BOND

(Sample period: Jan1973–Jun2010)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Est.</th>
<th>S.E.</th>
<th>Est.</th>
<th>S.E.</th>
<th>Mean</th>
<th>STD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance-to-default: $-DD_{it}$</td>
<td>0.230</td>
<td>0.012</td>
<td></td>
<td></td>
<td>0.159</td>
<td>0.008</td>
</tr>
<tr>
<td>Callable Term structure: $LEV_t$</td>
<td></td>
<td></td>
<td>-0.742</td>
<td>0.052</td>
<td>0.000</td>
<td>1.000</td>
</tr>
<tr>
<td>Callable Term structure: $SLP_t$</td>
<td></td>
<td></td>
<td>-0.165</td>
<td>0.032</td>
<td>0.000</td>
<td>1.000</td>
</tr>
<tr>
<td>Callable Term structure: $CRV_t$</td>
<td></td>
<td></td>
<td>-0.071</td>
<td>0.037</td>
<td>0.000</td>
<td>1.000</td>
</tr>
<tr>
<td>Callable Term structure: $VOL_t$ (%)</td>
<td></td>
<td></td>
<td>0.253</td>
<td>0.040</td>
<td>1.862</td>
<td>1.242</td>
</tr>
</tbody>
</table>
ACTUAL AND PREDICTED CREDIT SPREADS

(Jan1973–Jun2010)
OPTION-ADJUSTED EXCESS BOND PREMIUM

(Jan1973–Jun2010)
Excess Bond Premium and Economic Activity

(Sample period: Jan1973–Jun2010)

<table>
<thead>
<tr>
<th>Financial Indicator</th>
<th>Forecast Horizon: 3 months</th>
<th>Forecast Horizon: 12 months</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EMP</td>
<td>UER</td>
</tr>
<tr>
<td>Term spread</td>
<td>-0.102</td>
<td>0.182</td>
</tr>
<tr>
<td></td>
<td>[2.47]</td>
<td>[6.63]</td>
</tr>
<tr>
<td>Real FFR</td>
<td>-0.076</td>
<td>0.065</td>
</tr>
<tr>
<td></td>
<td>[1.66]</td>
<td>[2.16]</td>
</tr>
<tr>
<td>Predicted OA-GZ spread</td>
<td>-0.158</td>
<td>0.124</td>
</tr>
<tr>
<td></td>
<td>[4.19]</td>
<td>[5.95]</td>
</tr>
<tr>
<td>Excess bond premium</td>
<td>-0.201</td>
<td>0.275</td>
</tr>
<tr>
<td></td>
<td>[6.80]</td>
<td>[14.0]</td>
</tr>
<tr>
<td>Adj. $R^2$</td>
<td>0.704</td>
<td>0.407</td>
</tr>
</tbody>
</table>

NOTE: Parameter estimates are standardized; absolute t-statistics in brackets.
**Excess Bond Premium and Real GDP**
(Sample period: 1973:Q1–2010:Q2)

<table>
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<tr>
<th>Financial Indicator</th>
<th>Forecast Horizon: 1 quarter</th>
<th>Forecast Horizon: 4 quarters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Term spread</td>
<td>-0.213</td>
<td>-0.231</td>
</tr>
<tr>
<td></td>
<td>[2.07]</td>
<td>[3.35]</td>
</tr>
<tr>
<td>Real FFR</td>
<td>-0.084</td>
<td>-0.090</td>
</tr>
<tr>
<td></td>
<td>[0.79]</td>
<td>[0.66]</td>
</tr>
<tr>
<td>Predicted OA-GZ spread</td>
<td>-0.123</td>
<td>-0.166</td>
</tr>
<tr>
<td></td>
<td>[1.69]</td>
<td>[1.68]</td>
</tr>
<tr>
<td>Excess bond premium</td>
<td>-0.290</td>
<td>-0.238</td>
</tr>
<tr>
<td></td>
<td>[3.91]</td>
<td>[2.96]</td>
</tr>
<tr>
<td>Adj. $R^2$</td>
<td>0.239</td>
<td>0.307</td>
</tr>
</tbody>
</table>

**Note:** Parameter estimates are standardized; absolute $t$-statistics in brackets.
# Excess Bond Premium and AD-Components

*(Sample period: 1973:Q1–2010:Q2)*

<table>
<thead>
<tr>
<th>Financial Indicator</th>
<th>C-NDS</th>
<th>C-D</th>
<th>I-RES</th>
<th>I-ES</th>
<th>I-HT</th>
<th>I-NRS</th>
<th>INV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Term spread</td>
<td>-0.395</td>
<td>-0.511</td>
<td>-0.529</td>
<td>-0.378</td>
<td>-0.085</td>
<td>0.329</td>
<td>-0.136</td>
</tr>
<tr>
<td></td>
<td>[3.79]</td>
<td>[2.64]</td>
<td>[5.40]</td>
<td>[3.41]</td>
<td>[0.76]</td>
<td>[2.78]</td>
<td>[1.65]</td>
</tr>
<tr>
<td>Real FFR</td>
<td>0.128</td>
<td>0.110</td>
<td>0.037</td>
<td>-0.137</td>
<td>-0.158</td>
<td>-0.175</td>
<td>-0.059</td>
</tr>
<tr>
<td></td>
<td>[1.35]</td>
<td>[0.65]</td>
<td>[0.33]</td>
<td>[1.42]</td>
<td>[1.16]</td>
<td>[1.49]</td>
<td>[0.68]</td>
</tr>
<tr>
<td>Predicted OA-GZ spread</td>
<td>-0.144</td>
<td>0.088</td>
<td>-0.083</td>
<td>-0.147</td>
<td>-0.331</td>
<td>-0.141</td>
<td>-0.225</td>
</tr>
<tr>
<td></td>
<td>[1.67]</td>
<td>[0.68]</td>
<td>[1.14]</td>
<td>[1.60]</td>
<td>[3.51]</td>
<td>[1.64]</td>
<td>[3.40]</td>
</tr>
<tr>
<td>Excess bond premium</td>
<td>-0.152</td>
<td>-0.075</td>
<td>0.042</td>
<td>-0.465</td>
<td>-0.301</td>
<td>-0.553</td>
<td>-0.603</td>
</tr>
<tr>
<td></td>
<td>[2.15]</td>
<td>[0.56]</td>
<td>[0.60]</td>
<td>[4.22]</td>
<td>[3.24]</td>
<td>[5.35]</td>
<td>[8.53]</td>
</tr>
<tr>
<td>Adj. $R^2$</td>
<td>0.366</td>
<td>0.193</td>
<td>0.376</td>
<td>0.418</td>
<td>0.386</td>
<td>0.533</td>
<td>0.554</td>
</tr>
</tbody>
</table>

*NOTE:* Parameter estimates are standardized; absolute *t*-statistics in brackets.
Robustness Check: 1985–2010 Period

- Apparent decline in macroeconomic volatility since the mid-1980s:
  - Changes in the conduct of monetary policy
  - Changes in government policy (e.g., demise of Regulation Q)
  - Rapid growth of securities markets

- Changes in the structure of the corporate bond market:
  - Re-emergence of the market for speculative-grade debt
  - Decline in information costs associated with credit-risk analysis
  - Changes in investors’ risk perceptions
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  - Changes in investors’ risk perceptions
# Excess Bond Premium and Real GDP

*(Sample period: 1985:Q1–2010:Q2)*

<table>
<thead>
<tr>
<th>Financial Indicator</th>
<th>Forecast Horizon: 1 quarter</th>
<th>Forecast Horizon: 4 quarters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Term spread</td>
<td>-0.308</td>
<td>-0.449</td>
</tr>
<tr>
<td></td>
<td>[2.32]</td>
<td>[3.35]</td>
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<tr>
<td>Real FFR</td>
<td>0.384</td>
<td>0.360</td>
</tr>
<tr>
<td></td>
<td>[2.08]</td>
<td>[2.17]</td>
</tr>
<tr>
<td>Predicted OA-GZ spread</td>
<td>0.101</td>
<td>0.080</td>
</tr>
<tr>
<td></td>
<td>[0.86]</td>
<td>[0.58]</td>
</tr>
<tr>
<td>Excess bond premium</td>
<td>-0.423</td>
<td>-0.436</td>
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<tr>
<td></td>
<td>[3.25]</td>
<td>[3.86]</td>
</tr>
<tr>
<td>Adj. $R^2$</td>
<td>0.357</td>
<td>0.275</td>
</tr>
</tbody>
</table>

*NOTE: Parameter estimates are standardized; absolute $t$-statistics in brackets.*
Macroeconomic Implications

• 8-variable VAR(2) specification:
  ▶ log-difference of real PCE
  ▶ log-difference of real BFI
  ▶ log-difference of real GDP
  ▶ GDP price inflation
  ▶ 10-year (nominal) Treasury yield
  ▶ effective federal funds rate
  ▶ log-difference of the (value-weighted) price-dividend ratio
  ▶ option-adjusted excess bond premium

• Estimation period: 1973:Q1–2010:Q2
• EBP shocks identified using the Cholesky decomposition.
**Adverse EBP Shock**

Macroeconomic Variables

![Graphs showing the impact of an adverse EBP shock on various macroeconomic variables such as Consumption, Investment, Output, and Prices, with shaded bands indicating 95-percent confidence intervals.](image)

**NOTE:** Shaded bands denote 95-percent confidence intervals.
**Adverse EBP Shock**

**Financial Variables**

![Graphs of financial variables](Image)

**Note:** Shaded bands denote 95-percent confidence intervals.
**Forecast Error Variance Decomposition**

**Macroeconomic Variables**

- **Consumption**
- **Investment**
- **Output**
- **Prices**

**NOTE:** Shaded bands denote 95-percent confidence intervals.
**Forecast Error Variance Decomposition**

**Financial Variables**

- **Price-dividend ratio**
- **10-year Treasury yield**
- **Federal funds rate**
- **Excess bond premium**

**Note:** Shaded bands denote 95-percent confidence intervals.
**INTERPRETATION**

- The EBP provides a timely gauge of credit-supply conditions.
- Increase in the EBP leads to an economic downturn vis-à-vis the financial accelerator mechanism.
- Financial shocks may also cause variation in the risk attitudes of the marginal investor pricing corporate bonds:
  - Corporate bond market is dominated by large institutional investors
  - These financial intermediaries face capital requirements
  - A shock to their financial capital makes them act in a more risk-averse manner
  - Shift in their risk attitudes leads to an increase in the EBP (He & Krishnamurthy [2010]; Adrian, Moench & Shin [2010])
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EBP & Changes in Bank Lending Standards

(Jan1973–Sep2010)
EBP & FINANCIAL SECTOR PROFITABILITY
(Jan1973–Sep2010)
Evidence From Primary Dealers

- Primary Dealers (PDs): major banks and broker-dealers that trade in U.S. Government securities with the FRBNY:
  - By buying/selling securities for a fee and holding an inventory of securities PDs play a key role in financial markets
  - PDs are often highly leveraged and engage in active pro-cyclical management of leverage
- Collected monthly data on CDS spreads and equity valuations.
EBP & Financial Intermediary CDS Spreads
(Jan2003–Sep2010)

- Excess bond premium (left scale)
- Broker-dealers average 1-year CDS spread (right scale)

Lehman Bros. bankruptcy
Shocks to the Profitability of FIs

- 6-variable VAR(2) specification:
  - option-implied volatility on the S&P 500 (VIX)
  - excess (value-weighted) market return
  - excess (value-weighted) portfolio return of broker-dealers
  - average 1-year broker-dealer CDS spread
  - average 5-year broker-dealer CDS spread
  - option-adjusted excess bond premium
  - dummy for Sep2010 (Lehman Bros. bankruptcy)

- Estimation period: Jan2003–Sep2010

- Shocks to the profitability of FIs identified using the Cholesky decomposition.
Transmission of Profitability Shocks

NOTE: Shaded bands denote 95-percent confidence intervals.
• Information content of credit spreads reflects:
  ▶ Downside risk not well captured by other asset prices
  ▶ “Risk-aversion” of financial intermediaries

• Increases in spreads signal disruptions in credit markets that have important consequences for macroeconomic outcomes.

• Integrating asset pricing with macroeconomic models used in policy analysis is a necessary step to understanding the interaction between the financial sector and the real economy.
CONCLUDING REMARKS

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• Integrating asset pricing with macroeconomic models used in policy analysis is a necessary step to understanding the interaction between the financial sector and the real economy.
FGWZ(2012): MOTIVATION

- Forecasting economic activity in real time is hard.
- Amazingly little predictability beyond the current quarter: (Sims [2005]; Tulip [2005]; Faust & Wright [2009]; Edge & Gürkaynak [2011])
  - Greenbook four-quarter-ahead forecast of real GDP growth is no better that the unconditional mean.
- Estimated medium-scale DSGE models and complex statistical models cannot beat forecasts of output growth and inflation based on univariate autoregressions.
FGWZ (2012): Methodology

- Provides an evaluation of the marginal information of credit spreads in real-time economic forecasting.
- Utilizes portfolio credit spreads based on an extensive micro-level data set of secondary market bond prices. (Gilchrist, Yankov & Zakrajšek [2009]; Gilchrist & Zakrajšek [2011])
- Employs Bayesian Model Averaging (BMA) to forecast real-time measures of economic activity using portfolio credit spreads and many other asset market indicators:
  - BMA framework addresses model search and selection issues.
Measuring Credit Spreads & Default Risk

- Construct a risk-free security replicating the cash-flows of the corporate debt instrument:
  - Cash-flows discounted using continuously-compounded zero-coupon Treasury yields in period $t$.
- Measure default risk using the “distance-to-default:”
  \[ \text{DD} = \frac{\ln(V/D) + (\mu_V - 0.5\sigma_V^2)}{\sigma_V} \]
  - $V$, $\mu_V$, $\sigma_V$ estimated using data on $E$, $D$, $\mu_E$, $\sigma_E$.
  \[ \text{(Bharath & Shumway [2008])} \]
Call Option Adjustment

- More than one-half of bonds in our sample are callable, on average.

- Movements in risk-free rates—by changing the value of embedded call options—have an independent effect on prices of callable bonds.
  
  (Duffee [1998])

- Use an empirical credit-spread model to construct "option-adjusted" spreads.
  
  (Gilchrist & Zakrajšek [2011])
AVERAGE CREDIT SPREADS
(Jan1986–Jun2010)

Nonfinancial firms

Monthly

- Option-adjusted credit spread
- Raw credit spread

Financial firms

Monthly

- Option-adjusted credit spread
- Raw credit spread
BOND, STOCK, AND DD PORTFOLIOS

Procedure:

- Sort bond issuers into categories based on the cross-sectional distribution of DDs in month \( t - 1 \).
- Within each DD-category, sort bonds into maturity categories.
- For each month \( t \) calculate:
  - Average credit spread within each DD/maturity category.
  - Average excess stock return within each DD category.
  - Average DD within each DD quartile.

Use the same procedure to construct stock and DD portfolios for all U.S. nonfinancial and financial corporations.
The BMA Setup

- \( n \) possible (linear) forecasting models:

\[
y_{t+h} = \alpha + \beta_i x_{it} + \sum_{j=1}^{p} \gamma_j y_{t-j} + \epsilon_{t+h}, \quad i = 1, \ldots, n
\]

- Priors:
  - All models are equally likely: \( P(M_i) = 1/n. \)
  - Priors for \( \alpha, \gamma_1, \ldots, \gamma_p, \sigma^2 \): proportional to \( 1/\sigma. \)
  - \( g \)-prior for \( \beta_i \): \( N(0, \phi \sigma^2 (X_i'X_i)^{-1}) \).
The BMA Setup (cont.)

- Bayesian $h$-period-ahead forecast for model $M_i$:

$$
\tilde{y}_{T+h|T} = \hat{\alpha} + \tilde{\beta}_i x_{it} + \sum_{j=1}^{p} \hat{\gamma}_j y_{t-j}
$$

- $\hat{\alpha}, \tilde{\beta}, \hat{\gamma}_1, \ldots, \hat{\gamma}_p =$ OLS estimates
- $\tilde{\beta}_i = \left(\frac{\phi}{\phi+1}\right) \hat{\beta}_i =$ posterior mean of $\beta_i$

- Posterior probabilities (given the observed data $D$):
  - Posterior probability that the $M_i$ model is “true:”

$$
P(M_i|D) \propto P(D|M_i)P(M_i)
$$

- Marginal likelihood of the $M_i$ model:

$$
P(D|M_i) \propto \left[\frac{1}{1 + \phi}\right]^{-\frac{1}{2}} \times \left[\frac{1}{1 + \phi}SSR_i + \frac{\phi}{1 + \phi}SSE_i\right]^{-(T-p)/2}
$$
The BMA Forecast

- **BMA forecast:**
  \[
  \tilde{y}_{T+h|T} = \sum_{i=1}^{n} \tilde{y}_{T+h|T}^i \times P(M_i|D)
  \]

- **BMA forecasts depends on the value of \( \phi \):**
  - “Small” \( \phi \) \( \Rightarrow \) equal-weighted model averaging.
  - “Large” \( \phi \) \( \Rightarrow \) weighting models by their in-sample \( R^2 \).
  - Relationship between \( \phi \) and RMSPE is often U-shaped.
  - Benchmark: \( \phi = 4 \).
The Forecasting Setup

- Forecast economic activity in quarter $t, t + 1, \ldots, t + 4$ using macro data available through quarter $t - 1$ and asset market indicators at the end of the first month of quarter $t$:
  - **Economic activity indicators:** GDP, PCE, BFI, IP, nonfarm payrolls, unemployment rate, imports, exports
- All variables are in real time.
  - Including the option adjustment to credit spreads.
Predictors & Forecast Evaluation

- Predictors:
  - Option-adjusted credit spreads in DD-based bond portfolios.
  - Average DDs in DD-based portfolios (bond issuers, financial and nonfinancial firms).
  - Excess stock returns in DD-based portfolios (bond issuers, financial and nonfinancial firms).
  - 15 macroeconomic series.
  - 110 asset market indicators.

- BMA forecasts compared with forecasts based on an AR($p$) model.
# BMA Out-of-Sample Predictive Accuracy

**Predictor Set: All Variables**

<table>
<thead>
<tr>
<th>Economic Activity Indicator</th>
<th>Forecast Horizon ($h$ quarters)</th>
<th>$h = 0$</th>
<th>$h = 1$</th>
<th>$h = 2$</th>
<th>$h = 3$</th>
<th>$h = 4$</th>
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<tbody>
<tr>
<td>GDP</td>
<td></td>
<td>0.94</td>
<td>0.82</td>
<td>0.73</td>
<td>0.79</td>
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<td></td>
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<td>[0.01]</td>
<td>[0.00]</td>
<td>[0.02]</td>
<td>[0.05]</td>
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<tr>
<td>Business fixed investment</td>
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<td>0.70</td>
<td>0.87</td>
<td>0.87</td>
<td>0.86</td>
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<tr>
<td></td>
<td></td>
<td>[0.01]</td>
<td>[0.00]</td>
<td>[0.02]</td>
<td>[0.03]</td>
<td>[0.03]</td>
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<tr>
<td>Industrial production</td>
<td></td>
<td>0.97</td>
<td>0.95</td>
<td>0.95</td>
<td>0.93</td>
<td>0.87</td>
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<td>[0.06]</td>
<td>[0.07]</td>
<td>[0.08]</td>
<td>[0.06]</td>
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<tr>
<td>Private employment</td>
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<td>0.88</td>
<td>0.79</td>
<td>0.83</td>
<td>0.89</td>
<td>0.84</td>
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<tr>
<td></td>
<td></td>
<td>[0.01]</td>
<td>[0.00]</td>
<td>[0.01]</td>
<td>[0.05]</td>
<td>[0.03]</td>
</tr>
<tr>
<td>Unemployment rate</td>
<td></td>
<td>0.92</td>
<td>0.78</td>
<td>0.73</td>
<td>0.74</td>
<td>0.77</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[0.01]</td>
<td>[0.00]</td>
<td>[0.00]</td>
<td>[0.00]</td>
<td>[0.02]</td>
</tr>
</tbody>
</table>

**Note:** Relative MSPEs; bootstrapped $p$-values in brackets.
# BMA Out-of-Sample Predictive Accuracy

**Predictor Set:** All Variables Except Option-Adjusted Credit Spreads

<table>
<thead>
<tr>
<th>Economic Activity Indicator</th>
<th>Forecast Horizon ($h$ quarters)</th>
<th>$h = 0$</th>
<th>$h = 1$</th>
<th>$h = 2$</th>
<th>$h = 3$</th>
<th>$h = 4$</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP</td>
<td></td>
<td>0.96</td>
<td>0.95</td>
<td>0.95</td>
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<td>0.98</td>
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<td>[0.11]</td>
<td>[0.12]</td>
<td>[0.13]</td>
<td>[0.14]</td>
</tr>
<tr>
<td>Business fixed investment</td>
<td></td>
<td>0.90</td>
<td>0.91</td>
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<td>0.96</td>
<td>0.92</td>
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<tr>
<td></td>
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<td>[0.04]</td>
<td>[0.07]</td>
<td>[0.10]</td>
<td>[0.07]</td>
</tr>
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<td></td>
<td>0.98</td>
<td>1.04</td>
<td>1.11</td>
<td>1.11</td>
<td>1.07</td>
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<td>[0.63]</td>
<td>[0.50]</td>
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<tr>
<td>Private employment</td>
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<td>1.00</td>
<td>1.09</td>
<td>1.13</td>
<td>1.07</td>
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<td></td>
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<td>[0.23]</td>
<td>[0.53]</td>
<td>[0.45]</td>
<td>[0.24]</td>
</tr>
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<td>Unemployment rate</td>
<td></td>
<td>0.93</td>
<td>0.94</td>
<td>1.04</td>
<td>1.11</td>
<td>1.08</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[0.01]</td>
<td>[0.02]</td>
<td>[0.32]</td>
<td>[0.47]</td>
<td>[0.28]</td>
</tr>
</tbody>
</table>

**Note:** Relative MSPEs; bootstrapped $p$-values in brackets.
Which Predictors are the Most Informative?
(BMA posterior probabilities by predictor type)
E Volution of BMA Posterior Probabilities

(Four-quarter-ahead forecast horizon)
CONCLUDING REMARKS

• Credit spreads have been underutilized in real-time economic forecasting.

• Messy to deal with.

• Contain useful information for medium-term forecasts of economic activity.

• The predictive content appears to reflect almost entirely movements in the non-default component—that is, in the price of default risk rather than in the risk of default:

  (Gilchrist & Zakrajšek [2011])

  ▶ Downside risk not well captured by other asset prices.

    (Gourio [2010])

  ▶ “Risk-bearing capacity” of financial intermediaries.

    (He & Krishnamurthy [2010]; Adrian, Moench & Shin [2010])