Corporate Debt Maturity and the Real Economy

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Research Questions and Approach

- **Economic Questions:**
  - How do firms manage debt maturity in the presence of investment opportunities?
  - How does corporate debt maturity management reconcile with our understanding of capital structure and asset prices?

- **Novel Empirical Evidence:**
  - Aggregate Data: GDP / Investment Growth and long term debt share
  - Firm-Level Data: Investment / profitability rates and firm-specific long-term debt shares

- **Economic Model:**
  - Dynamic, heterogeneous firm model with investment and asset pricing
  - External finance through short-term debt, long-term debt, and equity issuance

Model Intuition and Takeaways

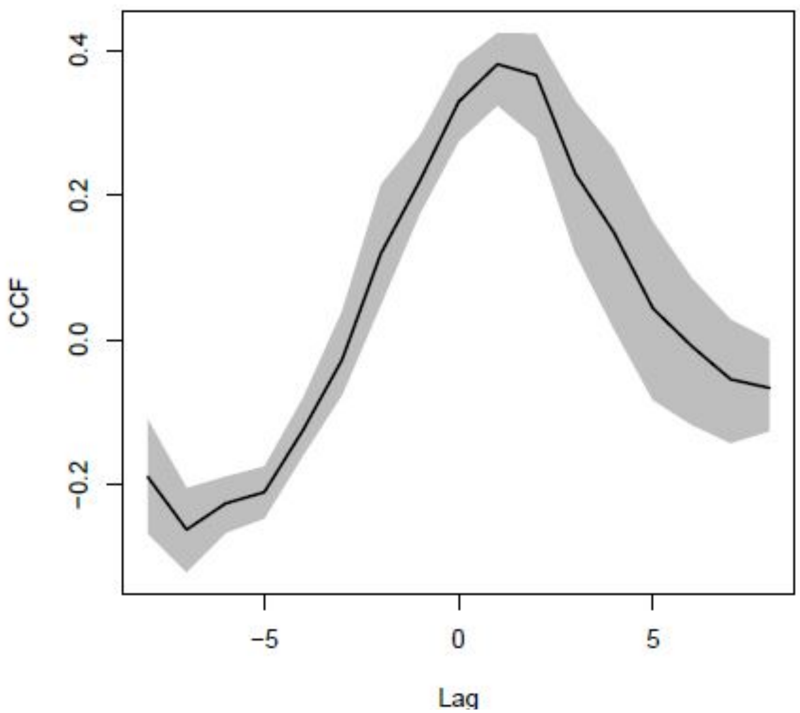
- **Essence of the Model:**

Long-term debt is the costlier debt security. But this security is worth it, when investment opportunities are more productive, likely in economic expansions.

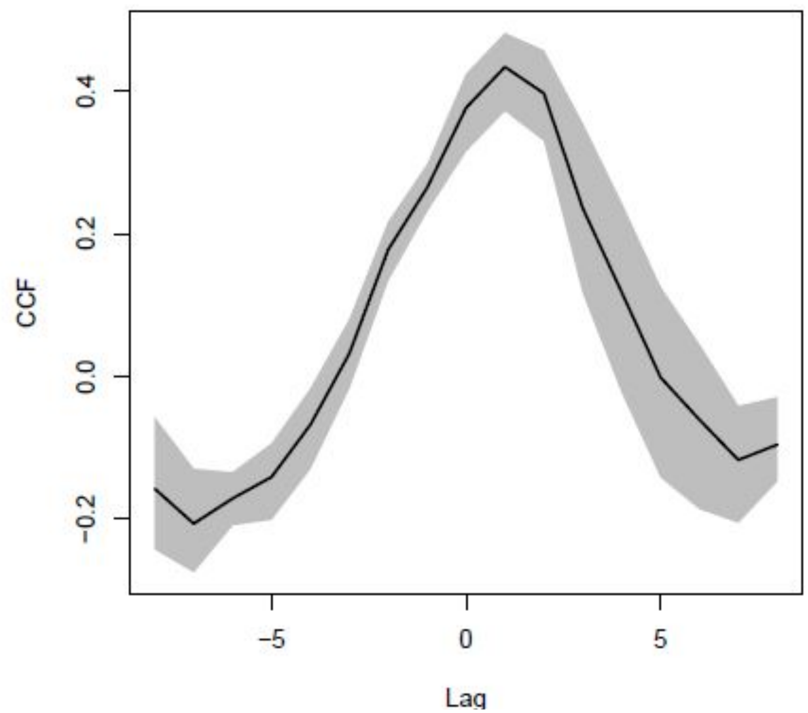
- **Contributions to the Literature**
  - Joint characterization of multiple debt securities and investment in a dynamic equilibrium model; asset prices play an important role here!
  - Endogenously-generated dynamic pecking order theory
  - Investment channel amplifies default and credit spreads
  - Adopt and extend techniques from the sovereign default literature

Aggregate Long Term Debt Share and Business Cycles

(i) $\rho(\triangle y_{t+k}, LTDR_t^c)$



(ii) $\rho(\triangle i_{t+k}, LTDR_t^c)$



Construct non-financial corporate, long-term debt ratio and remove non-stationarity via HP filter to receive $LTDR_t^c$. Shaded grey areas indicate bootstrapped standard errors taking into account time series properties.

Predictive Regressions – Aggregate Output

We run the following predictive regression of per-capita output growth:

$$\frac{1}{k}\sum_{i=1}^{k}\triangle y_{t+i} = \beta_0 + \beta_X' X_t + \beta_{LT} LTDR_t^c + error_{t+k}$$

Where *X* is a set of aggregate controls:

$$(\triangle y_t, \triangle c_t, \pi_t, pd_t, CredSpread_t, TermSpread_t, y_t^{3m}, \triangle Debt_t)$$

Coefficient	$k = 1Q$	2	3	4	5	6	7	8
β_{LT}	0.17***	0.15***	0.13***	0.11***	0.09*	0.07	0.05	0.04
t(β_{LT})	4.45	3.82	2.85	2.25	1.72	1.42	1.25	1.24
Adjusted R^2	0.30	0.36	0.34	0.34	0.29	0.26	0.23	0.19

Economic Magnitude: 1% additional long term debt is associated with ~.60% more annualized output growth, in the short term.

Pred. Regressions – Aggregate Investment

We run the following predictive regression of per-capita output growth:

$$\frac{1}{k}\sum_{i=1}^{k} \triangle i_{t+i} = \beta_0 + \beta_X' X_t + \beta_{LT} LTDR_t^c + error_{t+k}$$

Where *X* is a set of aggregate controls:

$$(\triangle y_t,\ \triangle c_t,\ \pi_t,\ pd_t,\ CredSpread_t,\ TermSpread_t,\ y_t^{3m}, \triangle Debt_t)$$

Coefficient	$k = 1Q$	2	3	4	5	6	7	8
β_{LT}	0.93***	0.92***	0.80***	0.64***	0.52***	0.37**	0.25	0.20
t(β_{LT})	4.41	4.95	4.41	3.45	2.70	2.00	1.62	1.61
Adjusted R^2	0.29	0.37	0.36	0.38	0.36	0.35	0.31	0.29

Economic Magnitude: 1% additional long term debt is associated with ~ 3% more annualized investment growth, in the short term.

Firm-Level Investment and LTDR

Regress capital-adjusted investment on other popular measures:

$$\frac{i_{it}}{k_{it}} = \beta_0 + \beta'_X X_{it} + \beta_{LT} LTDR_{it} + error_{it}$$

where *X* includes firm-level and aggregate controls.

Coefficient	(1)	(2)	(3)
$\beta_{LT} \times 100$	.203***	.254***	.373***
t(β_{LT})	3.05	3.84	4.43
Adjusted R^2	.226	.229	.203
Firm Controls	x	x	x
Macro Controls		x	x
Firm Fixed Effects			x

Economic Magnitude: One standard deviation's worth of more long-term debt is associated with ~1% more capital-adjusted investment.

Key Ingredients of the Economic Environment

- **Investment under Uncertainty:**

  Firms accumulate internal and external funds to invest into capital

- **Countercyclical Discount Factor ("SDF"):**

  Firms are more sensitive to cash flows on "rainy" days

- **Capital Structure:**

  Firms utilize both short and long-term debt, as well as equity issuance

- **Fair Valuation of Debt**

  Markets account for default risk and firm policies in debt pricing

- **Dynamic Problem of Equity-holders**

  Equity-holders maximize the discounted value of expected cash flows

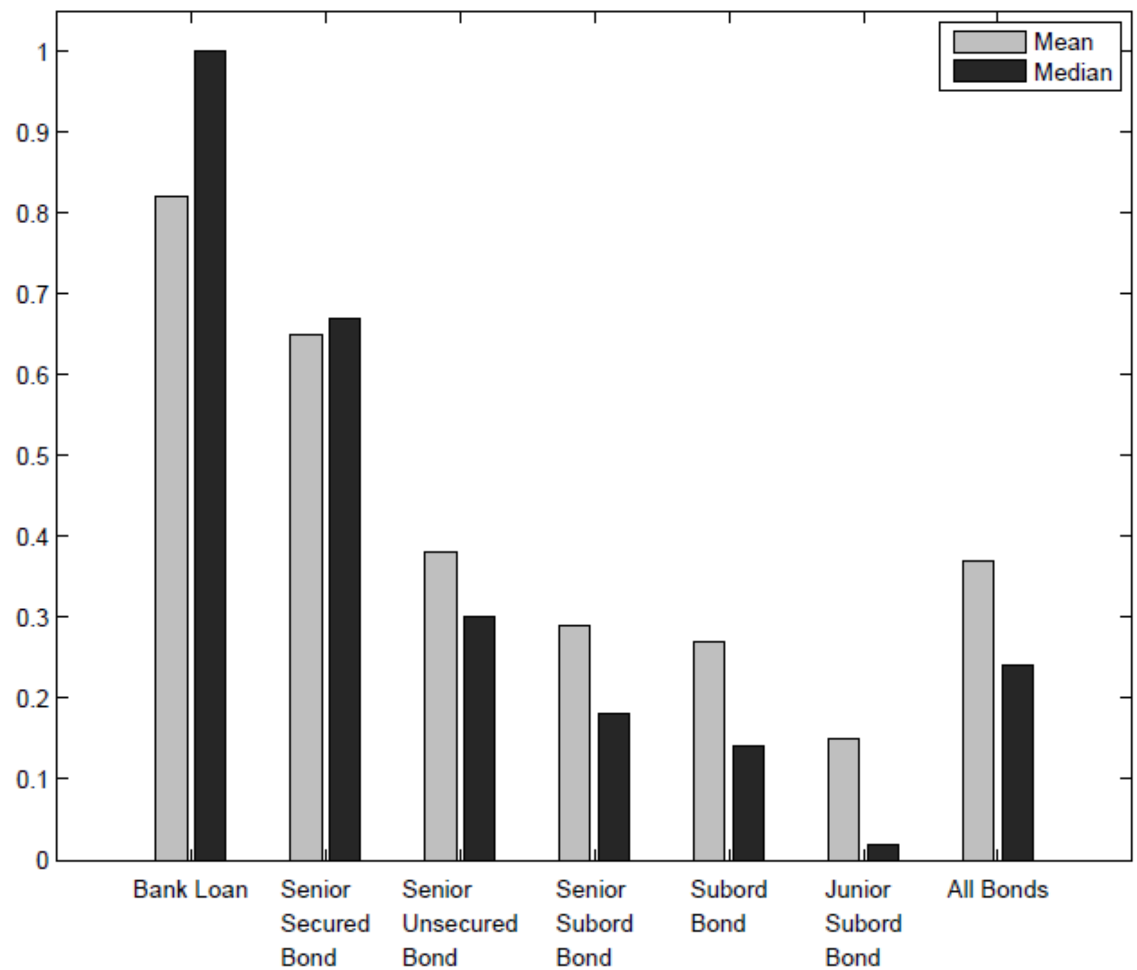
Model Overview

- Heterogeneous firms face two types of shocks and choose whether to continue operation (``Optimal Default")

- Investment, under uncertainty, externally financed by three capital market securities (Short-term debt, long-term debt, or equity issuance)

- Deviations from *Modigliani and Miller (1963):*
  - Two assumptions on short debt: collateralization and seniority ➔ **risk free short-debt**
  - Distress costs upon default, priced into long-term debt
  - Costly equity issuance
  - Coupon payments and tax shield

Recovery Rates on Debt



All data is from "Moody's Ultimate Recovery Database" and spans approximately 3500 loans and bonds over 720 US non-financial corporate default events. All data refers to the 20 years preceding the Financial Crisis (1987 – 2007).

Debt Pricing

- As short-term debt is risk free:

$$p_{it}^{S} = \mathbb{E}_t\left[M_{t+1}(1+c)\right]$$

- Long-term bonds are priced to break even, in ex-ante expectation:

$$\begin{aligned}
\underbrace{p_{it}^{L} b_{i,t+1}^{L}}_{\text{MV of Total Lent Funds}} &= \mathbb{E}_t\left[M_{t+1}\underbrace{(1-1_{\{\tilde{V}_{i,t+1}\leq 0\}})}_{\text{No Default}} \times \left(\underbrace{(\kappa_L + c) b_{i,t+1}^{L}}_{\text{``Dividend''}} + \underbrace{(1-\kappa_L) p_{i,t+1}^{L} b_{i,t+1}^{L}}_{\text{Future MV}}\right)\right] \\
&+ \mathbb{E}_t\left[M_{t+1}\underbrace{\left(1_{\{\tilde{V}_{i,t+1}\leq 0\}}\right)}_{\text{Default}} \times \underbrace{Z_{i,t+1}^{PD}}_{\text{Recovery}}\right]
\end{aligned}$$

$$p_{it}^{L} = p^{L}\left(A_{it}, k_{i,t+1}, b_{i,t+1}^{L}\right)$$

Shareholders' Problem

- Equity-holders maximize the sum of expected, discounted dividend payments, accounting for potential default
- The recursive formulation of the problem:

$$
\begin{aligned}
\tilde{V}_{it} &= \max_{\{k_{i,t+1}, b^S_{i,t+1}, b^L_{i,t+1}\}} \left\{ D_{it} \underbrace{-\Phi_e\left(D_{it}\right)}_{\text{equity issuance costs}} + \mathbb{E}_t\left[M_{t+1} W_{i,t+1}\right] \right\} \\
W_{i,t+1} &= \max\left\{\tilde{V}_{i,t+1},\ 0\right\}
\end{aligned}
$$

$$
\begin{aligned}
D_{it} &= \pi_{it} - \underbrace{\bar{V} f(X_t)}_{\text{fixed costs}} \\
&+ \tau(\delta k_{it} + c b^S_{it} + c b^L_{it}) \\
&- i_{it} - \Phi_k(i_{it}, k_{it}) k_{it} \\
&- (1+c) b^s_{it} - (\kappa_L + c) b^L_{it} \\
&+ \underbrace{p^S_{it} w^S_{it} + p^L_{it} w^L_{it}}_{\text{debt proceeds}} \underbrace{-\Phi_L(w^L_{it})}_{\text{debt issuance costs}}
\end{aligned}
$$

Tradeoffs of Capital Market Securities

- Suppose firm *i* wants to invest at time *t*, beyond what is available:

$$\underbrace{i_{it}}_{\text{desired investment}} > \underbrace{\pi_{it} + \tau\left(\cdot\right)}_{\text{profits + tax shield}} \underbrace{-(1+c)b_{it}^{S} - (\kappa_L + c)b_{it}^{L}}_{\text{current debt service}}$$

- The firm has three securities to choose from:
  - <u>Short-Term Debt</u>

    -- tax advantage on debt coupon

    -- firm value is not destroyed, no costs

  - <u>Long-Term Debt</u>

    -- tax advantage on debt coupon

    -- additional likelihood of bearing distress costs

  - <u>Equity Issuance</u>

    -- flotation costs to issue equity

Computational Methodology

- Two key equations govern the model:

$$\underbrace{\hat{V}_{it}}_{\text{MV of equity}} = \hat{V}\left(X_t, x_{it}, \hat{k}_{it}, \hat{b}^L_{it} \mid p^L(\cdot)\right)$$

$$\underbrace{p^L_{it}}_{\text{MV of long debt}} = p^L\left(X_t, x_{it}, \hat{k}_{i,t+1}, \hat{b}^L_{i,t+1} \mid \hat{V}(\cdot)\right)$$

- Standard iteration technique fails due to (1) discrete nature of default and (2) future dependency of bond price

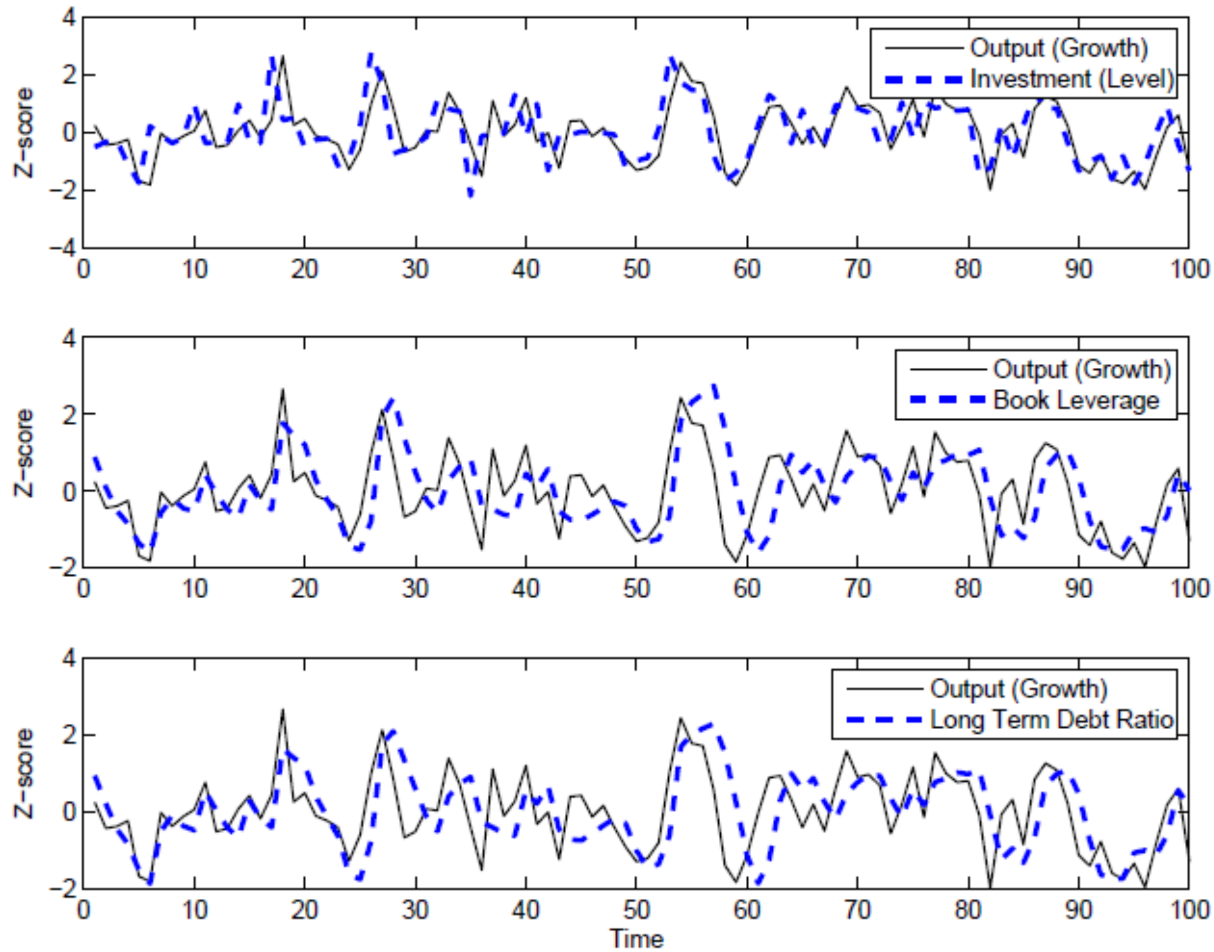
- Extend techniques from Chatterjee and Eyigungor (2012) and Gordon and Guerron-Quintana (2016)

- Summary of technique: add IID noise to dividends to dividends in value function so I can "smooth" out jumps

Calibration Overview

- For a given set of parameters:
  - Solve model for optimal policies
  - Simulate and generate empirical statistics
- Aggregate shocks are calibrated to match moments of consumption growth
- Calibrate remaining parameters to match cross-sectional and time series data related to investment, leverage, credit spreads, and default rates

Aggregate Behavior of the Model



A typical 100 quarter simulation of 3000 firms. All model data aggregate and all variables standardized to zero mean and unit variance.

Model vs. Data: Aggregate Statistics

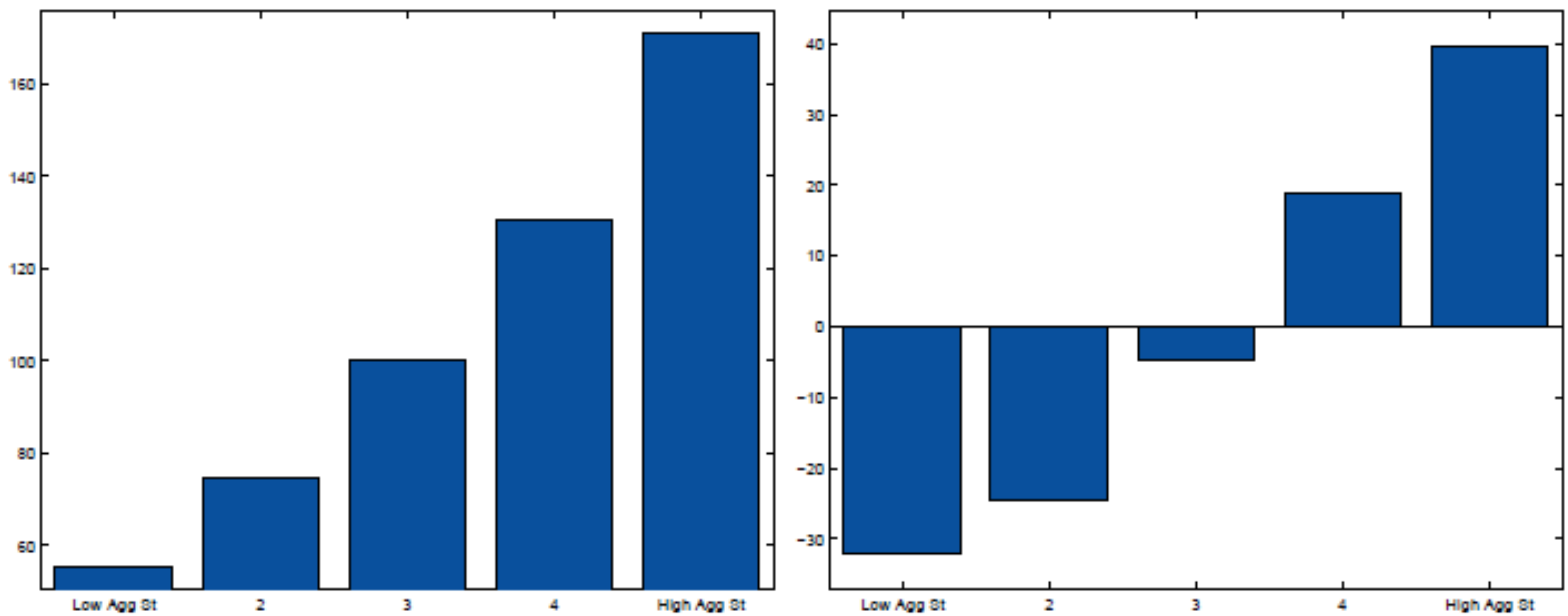
Variable	Description	Model	Data (2.5, 97.5%)
$\mathbb{E}\left(\Delta c_t\right)$	Mean Cons. Growth	.446	.493 (.397, .590)
$\sigma\left(\Delta c_t\right)$	Stdev Cons. Growth	.454	.466 (.413, .510)
$\rho\left(\Delta c_t, \Delta c_{t-1}\right)$	AR(1) Cons. Growth	.499	.450 (.345, .536)
$\rho\left(\Delta c_t, \Delta y_t\right)$	Corr(Cons. Growth, Output Growth)	.741	.804 (.750, .863)
$\rho\left(\Delta c_t, \Delta i_t\right)$	Corr(Cons. Growth, Investment Growth)	.444	.596 (.460, .743)
$\rho\left(\Delta c_t, \frac{\sum_i (b_{it}^S + b_{it}^L)}{\sum_i k_{it}}\right)$	Corr(Cons. Growth, Leverage)	.400	–
$\rho\left(\Delta y_t, \frac{\sum_i (b_{it}^L)}{\sum_i (b_{it}^S + b_{it}^L)}\right)$	Corr(Output Growth, Agg. LTDR)	.664	.323 (.264, .388)
$\rho\left(AggDefault_t, \Delta c_t\right)$	Corr(Agg. Default Rate, Cons. Growth)	-.365	-.223 (-.315, -.053)
$\rho\left(MeanCreditSpread_t, \Delta c_t\right)$	Corr(Agg. Credit Spread, Cons. Growth)	-.325	-.505 (-.659, -.345)

Model vs. Data: Firm-Level Statistics

Variable	Description	Model	Data (2.5, 97.5%)
$\mathbb{E}\left(\mathbb{E}_t\left(\frac{\pi_{it}}{k_{it}}\right)\right)$	Cross-Sec Mean of Profitability	.066	.022 (.020, .024)
$\mathbb{E}\left(\sigma_t\left(\frac{\pi_{it}}{k_{it}}\right)\right)$	Cross-Sec Stdev of Profitability	.017	.050 (.047, .053)
$\mathbb{E}\left(\mathbb{E}_t\left(\frac{i_{it}}{k_{it}}\right)\right)$	Mean of Investment Rate	.029	.040 (.035, .045)
$\mathbb{E}\left(\sigma_t\left(\frac{i_{it}}{k_{it}}\right)\right)$	Stdev of Investment Rate	.045	.057 (.050, .064)
$\mathbb{E}\left(\mathbb{E}_t\left(\frac{b^S_{it}+b^L_{it}}{k_{it}}\right)\right)$	Mean of Book Leverage	.193	.249 (.238, .263)
$\mathbb{E}\left(\mathbb{E}_t\left(\frac{b^L_{it}}{b^S_{it}+b^L_{it}}\right)\right)$	Mean of Long Debt Ratio	.520	.694 (.669, .719)
$400 \times \mathbb{E}\left(\mathbb{E}_t\left(\frac{\kappa_L+c}{p^L_{it}} - \frac{\kappa_L+c}{p^{*L}_{it}}\right)\right)$	Mean of Credit Spread	1.84	1.25 (.909, 1.65)
$400 \times \mathbb{E}\left(\sigma_t\left(\frac{\kappa_L+c}{p^L_{it}} - \frac{\kappa_L+c}{p^{*L}_{it}}\right)\right)$	Stdev of Credit Spread	12.30	–
$400 \times \mathbb{E}\left(\mathbb{E}_t\left(\mathbb{1}_{\text{Default},it}\right)\right)$	Mean of Default Rate	.968	1.08 (.422, 1.68)

Main Mechanism

(i) Funding Deficit by Agg. St. (Index) (ii) Percentage Long-Term Funding (%)



Funding deficit measures time series average of difference between dividends paid and debt raised. Deficit is indexed to median aggregate state. Right side figure provides ratio of long-term funding to deficit, as a percentage.

Cross-Sectional Behavior

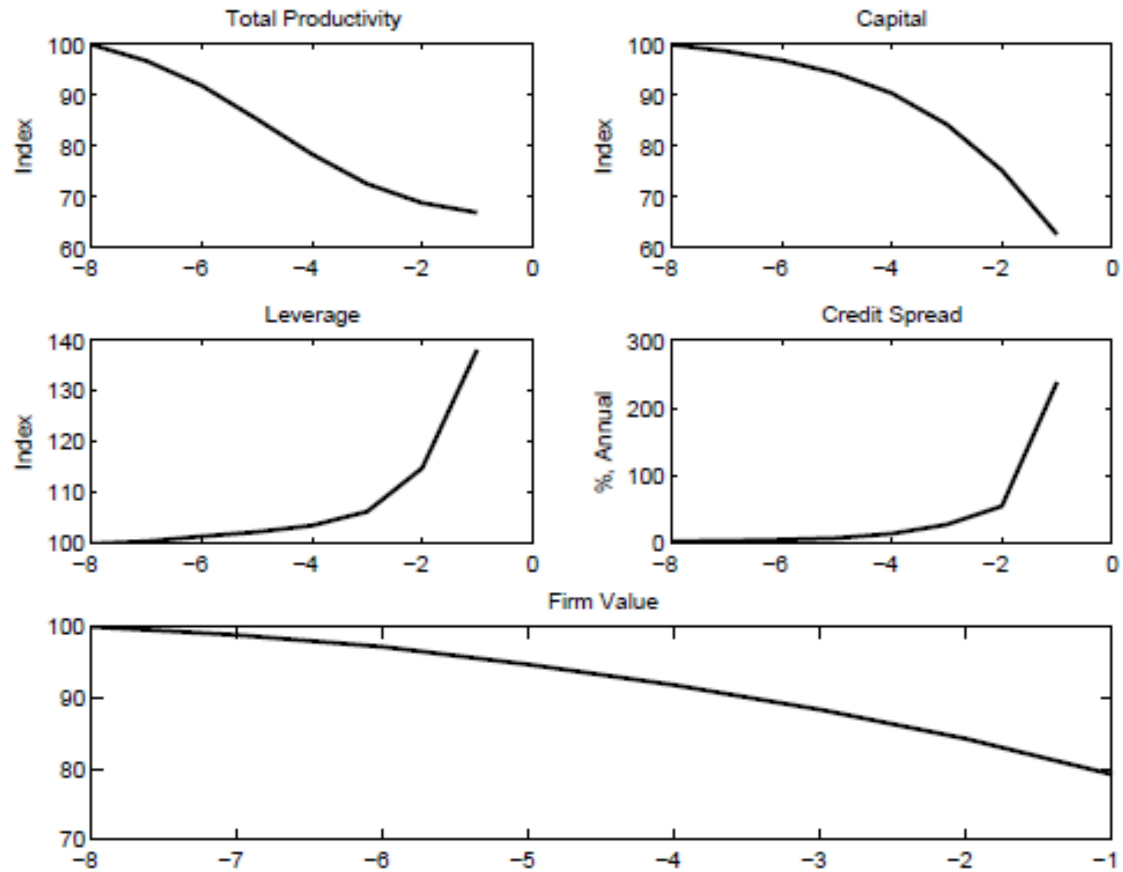
- What type of firms have more long-term debt? Does it have implications for aggregate investment & profits? Economic stability?

Mean of Variable	Quintile 1	2	3	4	5
Detrended Capital ($\hat{k}_{it}$)	1.07	1.24	1.35	1.45	1.67
Profitability $\left(\frac{\pi_{it}}{k_{it}}\right)$	.052	.058	.065	.071	.082
Investment Rate $\left(\frac{i_{it}}{k_{it}}\right)$	.012	.026	.031	.036	.042
Book Leverage $\left(\frac{b^S_{it}+b^L_{it}}{k_{it}}\right)$	.156	.186	.205	.213	.204
Book Long Term Debt Ratio $\left(\frac{b^L_{it}}{b^S_{it}+bi^L_{it}}\right)$	.417	.521	.553	.557	.530
Long Term Credit Spread (%, Annual)	6.56	.901	.686	.583	.468

Each period, non-defaulted firms are sorted by their value into five quintiles. Above numbers represent time series averages across groups.

Behavior Preceding Default

What is the role of endogenous investment for default?



Endogenous investment drives firms closer to the default boundary

Conclusion

- **Economic Questions:**
  - How do firms manage debt maturity in the presence of investment opportunities?
- **Empirical Evidence:**
  - Corporations extend their average debt maturity in economic booms
- **Economic Model:**
  - Dynamic, heterogeneous firm model with optimal investment, financing decisions, and realistic corporate bond pricing
- **Model Intuition:**
  - Long-term debt is costlier in equilibrium, but firms are willing to use it when investment opportunities are more productive, likely in economic expansions