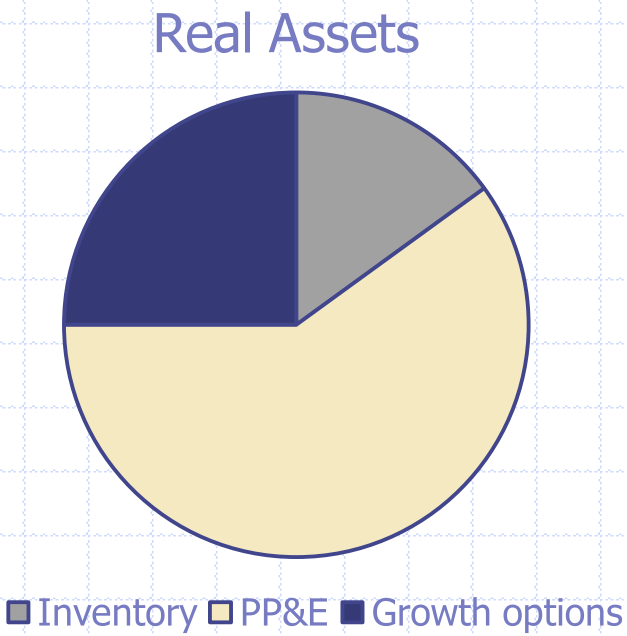
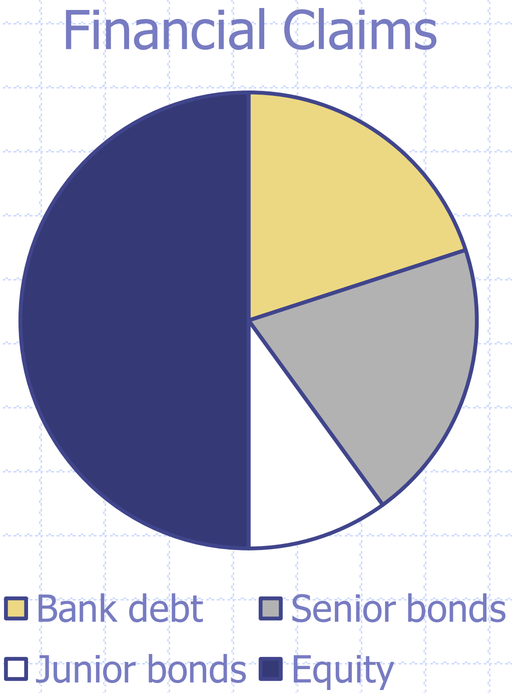
On the Fundamental Relation Between Equity Returns and Interest Rates

Jaewon Choi, UIUC
Matthew Richardson, NYU Stern
Robert Whitelaw, NYU Stern

The Impact of Interest Rates

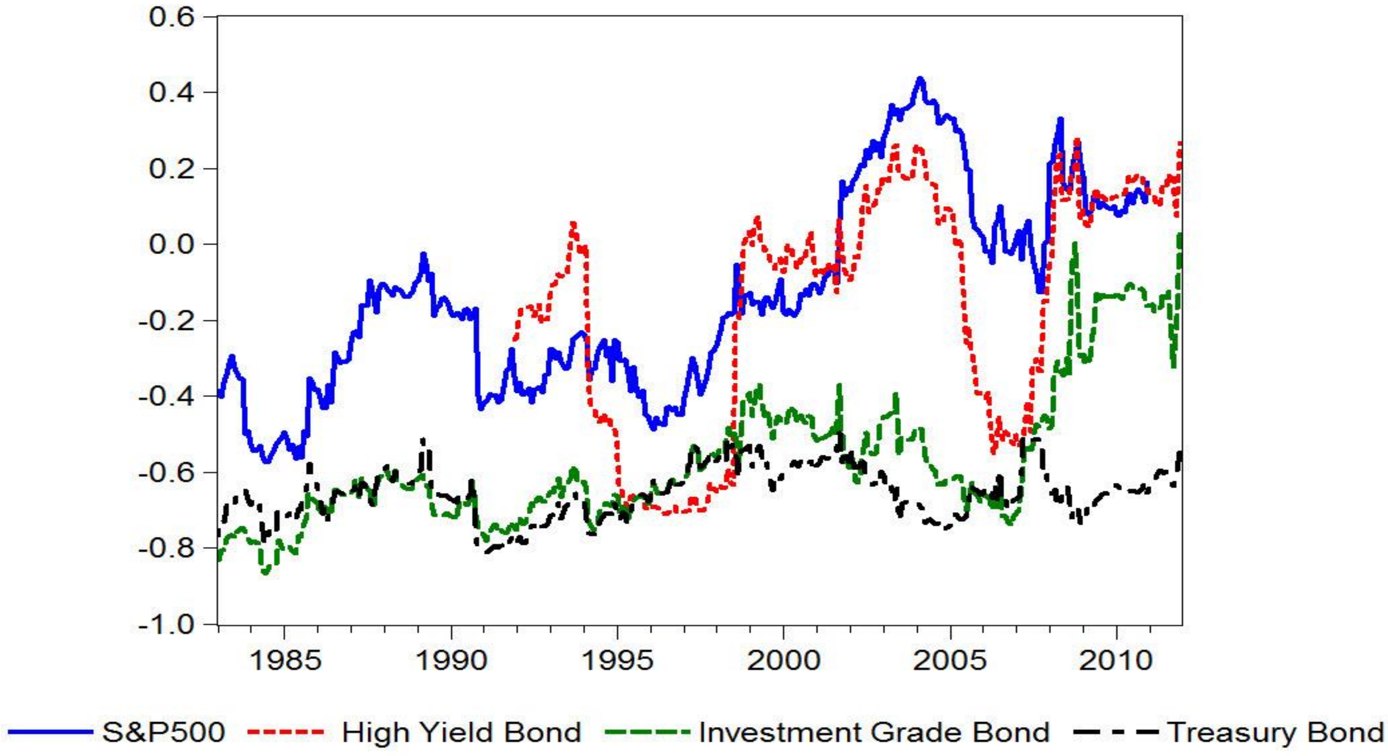




Two effects:

1. Δ interest rates → Δ asset value → Δ debt, Δ equity
2. Δ interest rates → Δ debt, Δ equity

Rolling Correlations



Correlations between returns and changes in interest rates are ordered by priority in the capital structure

Results

- Firms’ priority structure explains the relation between interest rates and corporate bond and equity returns
  - Higher leverage, lower priority → more negative duration
  - Confirmed both at the firm and portfolio levels
- Capital structure effects are important for interpreting existing evidence
  - Partially explains time-varying correlation between stocks and bonds
  - Reveals potentially misleading decomposition into default and term premiums

Outline

- Theory based on capital structure priority
- Data and stylized facts
- Empirical evidence
- Reinterpreting existing empirical results

A Contingent Claims Approach

- Equity and debt are claims (options) on the underlying assets [Merton (1974), Rabinovitch (1989)]

$$dV_t = r_t V_t dt + \sigma_V V_t dZ_t$$
$$dr_t = q(m - r_t)dt + v dW_t$$
$$dZ_t \cdot dW_t = \rho dt$$

$$D_s = K_s B(\tau, r) - P(V, K_s, \tau, r, \sigma_V)$$
$$D_j = K_j B(\tau, r) + P(V, K_s, \tau, r, \sigma_V) - P(V, K_s + K_j, \tau, r, \sigma_V)$$
$$E = V + P(V, K_s + K_j, \tau, r, \sigma_V) - (K_s + K_j) B(\tau, r)$$

Duration

Modified duration

$$\mathrm{Dur}(D_s) = -\frac{\partial D_s}{\partial V}\frac{V}{D_s}\frac{\rho\sigma_V}{v} - \frac{\partial D_s}{\partial r}\frac{1}{D_s}$$

$$\mathrm{Dur}(D_j) = -\frac{\partial D_j}{\partial V}\frac{V}{D_j}\frac{\rho\sigma_V}{v} - \frac{\partial D_j}{\partial r}\frac{1}{D_j}$$

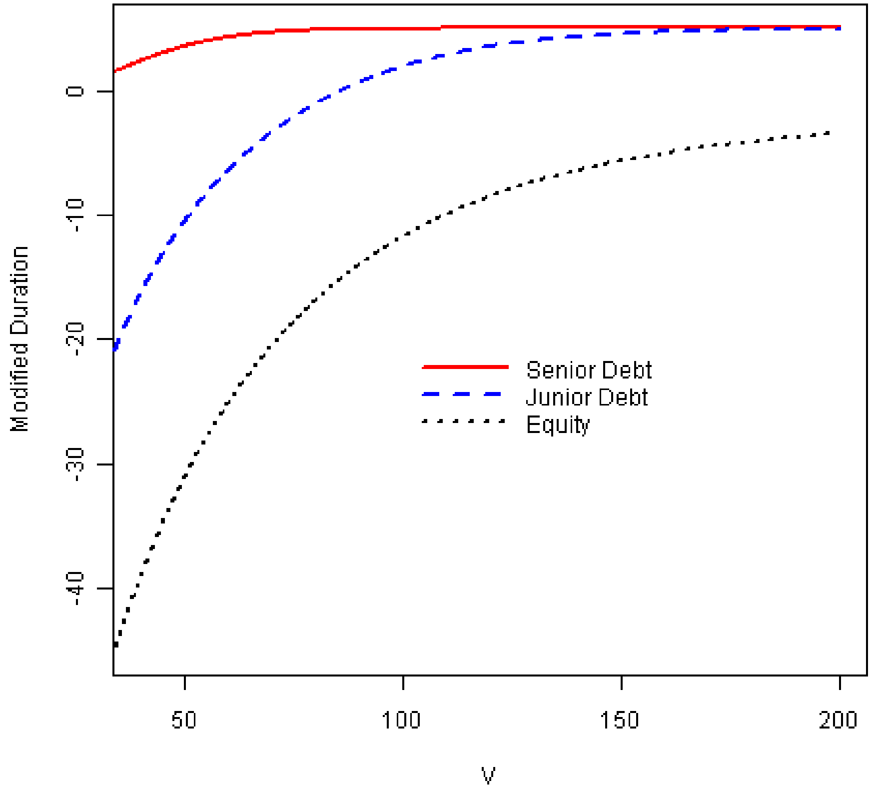
$$\mathrm{Dur}(E) = \underbrace{-\frac{\partial E}{\partial V}\frac{V}{E}\frac{\rho\sigma_V}{v}}_{1} \underbrace{- \frac{\partial E}{\partial r}\frac{1}{E}}_{2}$$

Two effects:

1. An asset duration component
2. A capital structure component

$$\frac{E}{V}\mathrm{Dur}(E) + \frac{D_s}{V}\mathrm{Dur}(D_s) + \frac{D_j}{V}\mathrm{Dur}(D_j) = \mathrm{Dur}(V) = -\frac{\rho\sigma_V}{v}$$

Modified Duration: An Example



- Duration is more negative for lower priority securities
- Leverage magnifies the duration effect

Data

- Procedure
  - Map out firm's capital structure
  - Construct returns for each security
  - Compute asset returns as weighted average of security returns
- Summary statistics
  - Coverage: 89.6% of debt structure (VW)
  - Priority: ~30% with multiple priority bonds
  - Maturity: ~6 years on avg
  - Leverage: 0.75 avg and 0.32 median D/E (mkt values)

“Simple” Duration Estimates

$$R_t^i = \alpha + \beta(-\Delta i_t) + \varepsilon_t$$

Leverage	Senior	Junior	Equity	Asset
Zero			-0.26	-0.26
1	3.18	2.45	-0.46	-0.17
2	3.04	2.62	0.04	0.51
3	2.79	2.41	0.04	0.83
High	2.22	1.81	0.29	0.87

- Within leverage buckets, duration increases with priority
- Asset duration increases with leverage

Main Empirical Specification

$$R_{t+1} = \alpha + \beta_t \tau(-\Delta i_{t+1}) + \theta_t RA_{t+1} + \varepsilon_{t+1}$$

$$\beta_t = \beta_0 + \beta_1 L_t + \beta_2 P_t + \beta_3 L_t P_t + \beta_4 Z_t$$

$$\theta_t = \theta_0 + \theta_1 L_t + \theta_2 P_t$$

R – Bond or equity returns
τ – Time to maturity
RA – Firm asset return
L – Firm leverage, log(book debt/market value of assets)
P – Bond priority, 0-1, 1 being the highest priority
Z – Fixed effects for convertible, callable, floating rate, sinking fund, and asset-backed bonds

Results

	$\tau(-\Delta i)$	$L \cdot \tau(-\Delta i)$	$P \cdot \tau(-\Delta i)$	RA	$L \cdot RA$	$P \cdot RA$
Assets	0.55	0.16				
Equity	-0.63	-0.18		1.65	0.22	
Bonds	0.27	-0.03	0.05	0.48	0.11	-0.14

1. Assets are positive duration, more so for levered firms
2. Equity is negative duration (once you control for asset effects), more negative as leverage increases
3. Bonds are positive duration, which
   a. Decreases with leverage
   b. Increases with priority

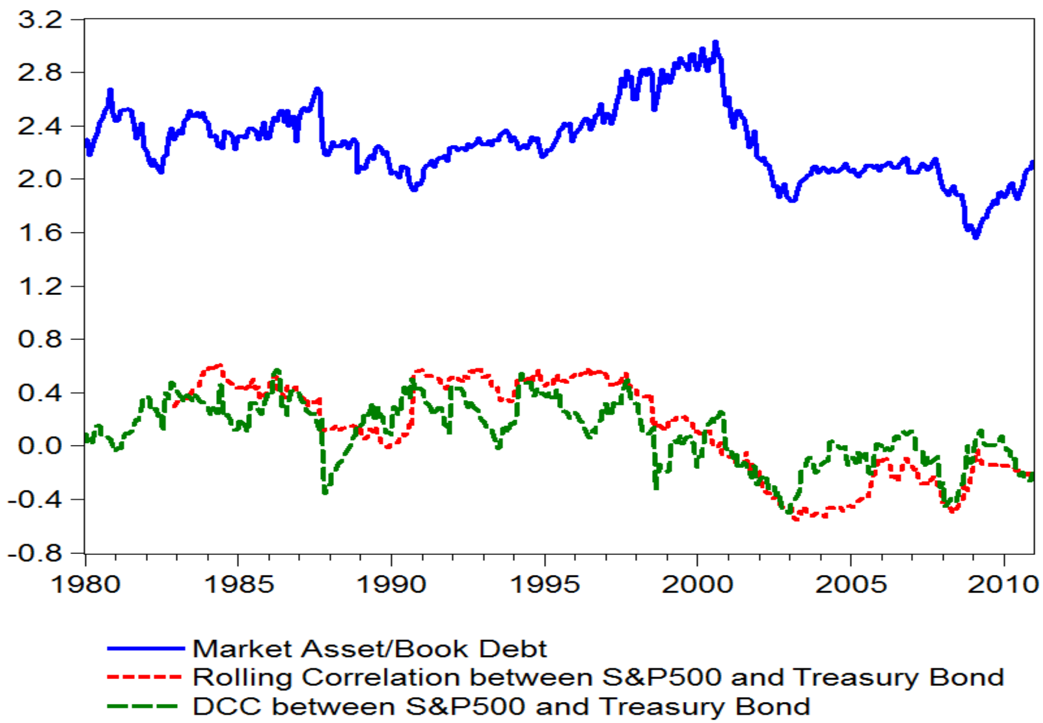
Portfolio Level Analysis

$$R_t = \alpha + \beta(-\Delta i_t) + \varepsilon_t$$

	Senior	Junior	Equity
AA	3.97	3.02	0.61
BBB	3.21	3.00	0.24
B	0.69	0.44	-3.52

1. Duration increases in priority
2. Duration increases in rating (decreases in leverage)
3. The differences are large between investment grade and high yield

Time-Varying Correlations between Equity and Debt



High correlation between debt-equity return correlation and market level leverage: 0.63

Decomposing Returns into Term and Default Premiums

- The traditional approach:

$$R_t - R_t^F = \alpha + \beta_1 \underbrace{(R_t^{LTG} - R_t^F)}_{\text{Term}} + \beta_1 \underbrace{(R_t^{Corp} - R_t^{LTG})}_{\text{Default}} + \varepsilon_t$$

- But the default factor does not isolate default risk. Corporate bonds' duration can be very short if they are low priority claims → default factor contains negative term premium
- In contrast, corporate minus "short-term" government bond isolates default risk.

Traditional Specification Misleading

$$\text{Def}\,1 = R_t^{Corp} - R_t^{LTG} \qquad \text{Def}\,2 = R_t^{Corp} - R_t^{5Yr}$$

	AAA	AA	A	BBB	BB	B
Term	0.56	0.74	0.81	0.95	1.01	1.58
Def1	0.27	0.36	0.49	0.81	1.36	2.43
Term	0.39	0.52	0.52	0.47	0.21	0.15
Def2	0.04	0.05	0.21	0.50	1.03	1.99

- Are AAA bonds really exposed to default risk?
- Exposures to both term and default premiums are exaggerated

Conclusion

- Capital structure matters!
  - Equity is not assets
  - Leverage and priority strongly influence interest rate sensitivity
- Security-specific effects also exist in portfolios/indices
  - Time-varying debt-equity correlations
  - Term and default premiums
  - Corporate bond betas
  - Return predictability
  - Inflation and security returns