A Literature Review on Macroeconomics and Capital Structure

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February 16, 2016

The Central Question

- How macro economic conditions affect capital structure choice.
- Macro economic conditions include
  - Consumption growth rate and volatility.
  - Asset liquidity.
  - Investment opportunities.
  - ...

Multiple Dimensions of Capital Structure Change

- Equity issuance $\Delta E(t)$ and debt issuance $\Delta D(t)$.
- Equity and debt level $E(t)$ and $D(t)$.
- Leverage $L(t) = D(t)/(D(t) + E(t))$, including book leverage and market leverage.

- When should we measure these changes?
  - At refinancing point
  - Time average

An Overview

- Empirical Research
  - Empirical evidence dates back to [Hickman, 1953], on the volume of stock and bond financing.
  - Empirical evidence tends to contradict each other in terms of cyclicality of debt/equity financing and leverage dynamics.
- Theoretical Research
  - Theoretical studies that link macro conditions with capital structure starts from [Choe et al., 1993]. The most outstanding stream of literature starts from [Hackbarth et al., 2006] that uses the regime shift approach for macro conditions.
  - There are many well-established theories on capital structure and all of them are related to macro conditions, providing potentially conflicting predictions.

Theory

Theories – Optimal Capital Structure

- Trade-off theory.
  - In general, defaults are more costly in economic downturns, because of lower liquidity and higher SDF. $\Rightarrow$ lower optimal leverage in downturns $\Rightarrow$ pro-cyclical leverage at refinancing point
- Agency theory.
  - Debt overhang and risk shifting are more likely in downturns.
  - $\Rightarrow$ lower optimal leverage in downturns $\Rightarrow$ pro-cyclical leverage at refinancing point
- Asymmetric information.
  - At economic downturns, there is more uncertainty in the cash flows, and thus more asymmetric information between managers and outside investors. $\Rightarrow$ Less equity issuance $\Rightarrow$ Pro-cyclical equity issuance

A Summary of Theoretical Research

Table: A Summary of Theory Papers on Macro and Capital Structure

	ΔD	ΔE	D	E	$L = D/(D+E)$
[Hackbarth et al., 2006]	+		+	+	− (static, ref pt.)
[Chen, 2010]	+			+	+ (dyn, ref pt.)
					− (dyn, time avg)
[Bhamra et al., 2010b] and	+			+	+ (dyn, ref pt.)
[Bhamra et al., 2010a]					− (dyn, time avg)
[Jermann and Quadrini, 2006]	+	−			
[Levy and Hennessy, 2007]	+		−	+	− (time avg)
[Choe et al., 1993]	−	+			

+ means procyclical and − means countercyclical. D denotes the market value of debt. E denotes the market value of equity. ΔE and ΔD are net issuances. $D/(D+E)$ is the market leverage. All measures except leverage are time average.

Theories of Macro and Capital Structure

Theory 1: [Hackbarth et al., 2006]

- Firm's EBIT

$$f(x_t, y_t) = x_t y_t$$

$$dx_t = \mu x_t dt + \sigma x_t dW_t$$

  y_t follows a two state Markov Chain y_L and y_H with $y_L > y_H > 0$.
- Based on tradeoff theory: Bankruptcy cost and tax shield.
- Forward looking will make optimal leverage **countercyclical**.
  - Without regime shift, the leverage will be the same for cases (1) $y_t = y_L$ forever and (2) $y_t = y_H$ forever.

Theories of Macro and Capital Structure

- Abandonment value (before bankruptcy costs)

$$A_i(x) = E[\int_0^\infty e^{-rt}(1-\tau)x_t y_t dt | x_0 = x, y_0 = y_i],\ i = L, H$$

$$\sim h(1-\tau)xy_i + (1-rh)\lambda_i h \cdot A_{-i}(x+h) + (1-rh)(1-\lambda_i h)\cdot A_i(x+h)$$

- ODE system (easily solvable)

$$rA_i(x) = (1-\tau)xy_i + \mu x A_i'(x) + \frac{\sigma^2}{2}x^2 A_i''(x) + \underbrace{\lambda_i(A_{-i}(x) - A_i(x))}_{\text{regime shift}}$$

Theories of Macro and Capital Structure

- Default Boundary
  - To solve the problem, an important trick is to intuitively derive the optimal default boundary for $y_t \in \{y_L, y_H\}$ (no shifting regime). The standard way of writing the equity value with a different setting $y_t = y_i$ for all $t \geq 0$ is

$$(\frac{y_i x}{r-\mu} - \frac{c}{r})(1-\tau) + A(x, X^D)(-\frac{y_i X_D}{r-\mu} + \frac{c}{r})(1-\tau)$$

    with optimal boundary

$$X_i^D = \beta / y_i$$

  - So naturally $X_L^D > X_H^D$
  - $X_i^D y_i = \beta$ is constant. Are macro conditions varying?
- When there is shifting regime, the relationship is maintained, $x_L^* > x_H^*$.

Theories of Macro and Capital Structure

- Let $d_i(x_t)$ be the valuation of debt at time t (because of constant principal, it is only a function of x_t) when $y_t = y_i$, $i \in \{L, H\}$.

$$d_i(x) = E[\int_0^\infty \mathbf{1}(t \leqslant \tau_D)(c + mp)e^{-mt}dt | x_0 = x]$$

- For $x_H^* \leq x \leq x_L^*$,

$$\begin{cases} \mu x d_H{}'(x) + \frac{\sigma^2}{2}x^2 d_H{}''(x) + \lambda_H(\alpha_L A_L(x) - d_H(x)) + c + mp \\ d_L(x) = \alpha_L A_L(x) \end{cases}$$

- For $x > x_L^*$,

$$\begin{cases} \mu x d_H{}'(x) + \frac{\sigma^2}{2}x^2 d_H{}''(x) + \lambda_H(d_L(x) - d_H(x)) + c + mp \\ \mu x d_L{}'(x) + \frac{\sigma^2}{2}x^2 d_L{}''(x) + \lambda_L(d_H(x) - d_L(x)) + c + mp \end{cases}$$

Theories of Macro and Capital Structure

- Model Prediction (static capital structure)
  - Countercyclical optimal leverage
    $L_i^*(m,p) = L_i(x, c^*(x), m, p) = d_i^*(x, c, m, p)/v_i^*(x, c)$.
  - Default is not more costly in bad state in [Hackbarth et al., 2006].

	Contraction coupon	Regime leverage	Expansion coupon	Regime leverage
Base	0.1196	19.72	0.1206	16.61
$\sigma = 0.20$	0.1513	24.97	0.1523	21.03
$\sigma = 0.30$	0.0958	15.70	0.0967	13.24
$\lambda_L = 0.10$	0.1064	19.91	0.1082	15.98
$\lambda_L = 0.20$	0.1289	19.57	0.1295	17.02
$\overline{T} = 3$	0.0910	15.31	0.0913	12.83
$\overline{T} = 7$	0.1453	23.39	0.1473	19.83

Theories of Macro and Capital Structure

- Is low leverage puzzle solved?

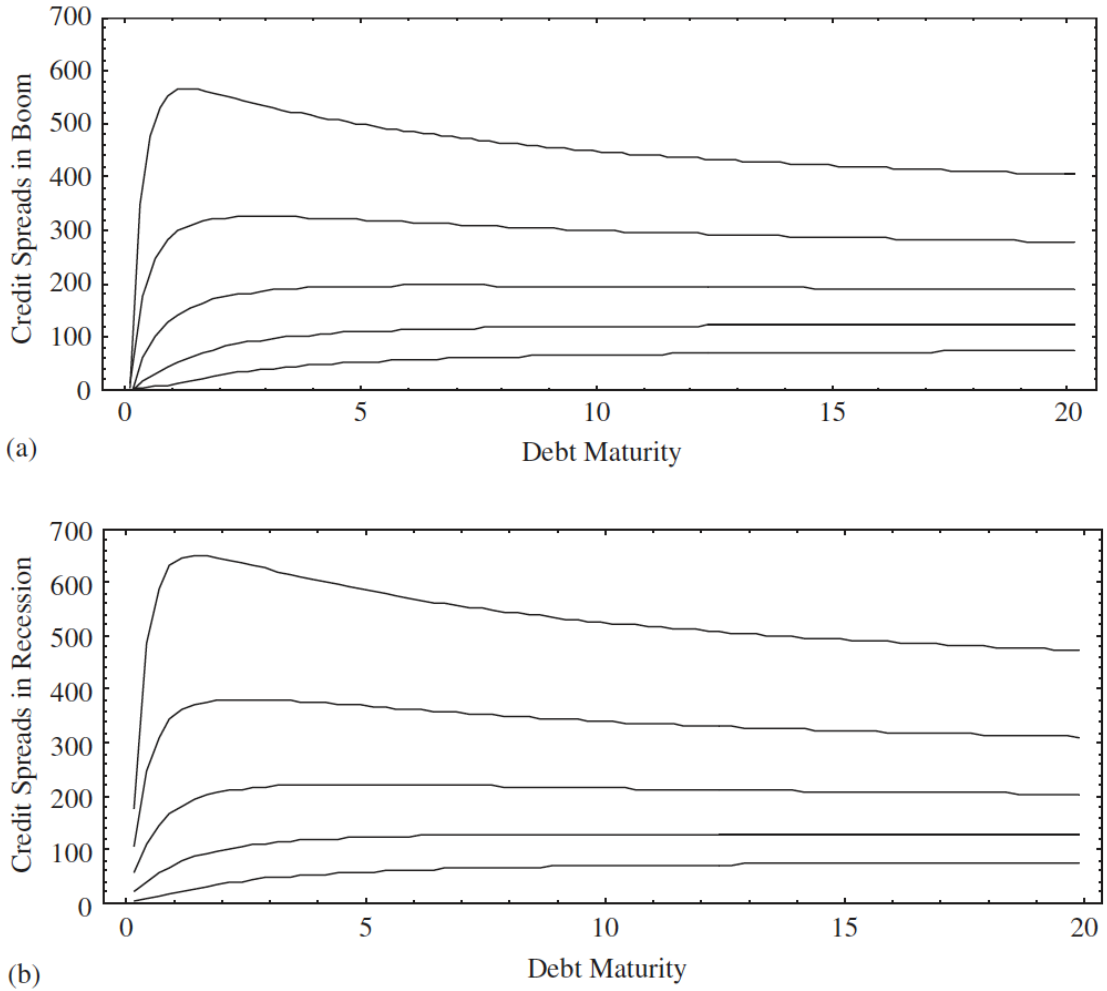
	Parameter choices
risk free interest rate	$r = 0.055$
initial level of cash flow	$x_0 = 1$
growth rate of cash flows	$\mu = 0.005$
volatility of cash flows	$\sigma = 0.25$
tax advantage of debt	$\tau = 0.15$
recovery rate on assets	$\alpha_H = \alpha_L = 0.6$
persistence of shocks	$\lambda_L = 0.15, \lambda_H = 0.1$
average debt maturity	$\overline{T} = 5$ $(m = 0.2)$

- Note: y_H/y_L is suppressed in [Chen, 2010], and instead they use

$$\frac{A_H(x) - A_L(x)}{A_L(x)} = 0.2 \quad (\Rightarrow y_H/y_L = 4)$$ Is this reasonable?

Theories of Macro and Capital Structure

- Credit spreads for different leverages (30%, 40%, $\cdots$, 70%)



Theories of Macro and Capital Structure

- A summary of [Hackbarth et al., 2006]
  - A very tractable model. Regime shift with Markov chain.
  - It generates low leverage, but with unbelievable productivity shocks.
  - The term structure is quite unusual.
  - The most important feature of macro economic cycle is missing: the pricing kernel. So it generates wired credit spreads, and the cyclicality of leverage is the opposite to our intuition.

Theories of Macro and Capital Structure

Theory 2: [Bhamra et al., 2010a]

- This paper captures economic cycles much better than [Hackbarth et al., 2006] by introducing a pricing kernel from consumers and integrate it with capital structure.
- There is a representative household with stochastic differential utility

$$U_t = E_t\left(\int_t^\infty f(c_s, U_s)ds\right)$$

and consumption process

$$\frac{dC_t}{C_t} = g_t dt + \sigma_{C,t} dB_{C,t}$$

- Fixing default probabilities, higher intertemporal risks will make default more costly, providing household doesn't like long-run risks (Relative Risk Aversion $>$ 1/Elasticity of Intertemporal Substitution).

Theories of Macro and Capital Structure

- Each firm f produces a perpetual stream of cash flows

$$\frac{dX_{n,t}}{X_{n,t}} = \theta_t dt + \sigma_X^{id} dB_{X,n,t}^{id} + \sigma_{X,t}^{s} dB_{X,t}^{s}$$

  and the aggregate output is X_t.
- Production and consumption are correlated.

$$dB_{X,t}^{s} dB_{C,t} = \rho_{XC} dt$$

- Consumption is a sum of output and wages.

$$C = \Sigma_{n=1}^{N} X_n + W$$

Theories of Macro and Capital Structure

- There are two states of the world, 2 is better.
  - Consumption growth $g_t \in \{g_1, g_2\}$, $g_1 < g_2$
  - Production growth $\theta_t \in \{\theta_1, \theta_2\}$, $\theta_1 < \theta_2$
  - Consumption volatility $\sigma_{C,t} \in \{\sigma_{C,1}, \sigma_{C,2}\}$, $\sigma_{C,1} > \sigma_{C,2}$
  - Systematic production growth volatility $\sigma^s_{X,t} \in \{\sigma^s_{X,1}, \sigma^s_{X,2}\}$, $\sigma^s_{X,1} > \sigma^s_{X,2}$
- Denote state of the world as v_t. Under risk-neutral probabilities, the transition rates λ_1 and λ_2 are distorted

$$\hat{\lambda}_1 = \lambda_1 / w < \lambda_1, \quad \hat{\lambda}_2 = \lambda_2 w > \lambda_2$$

- So macro economic conditions are reflected in the risk neutral pricing.

Theories of Macro and Capital Structure

- Equity holders decide optimal refinancing boundaries as well as optimal coupons and default boundaries.
- To study cyclical behavior of leverage, we have to do simulations.

Theories of Macro and Capital Structure

Parameter estimates

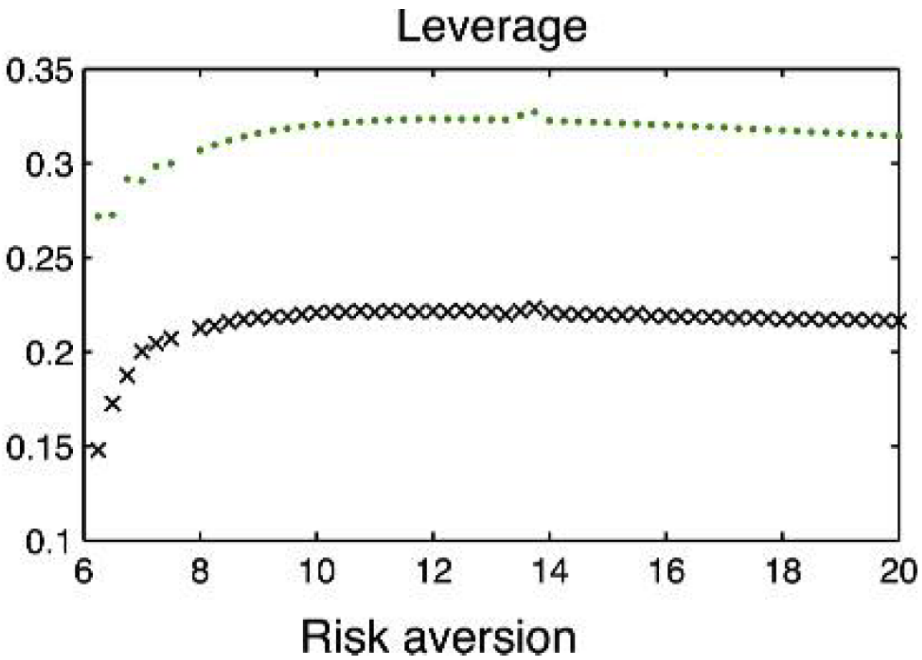
Panel A: Unconditional estimates

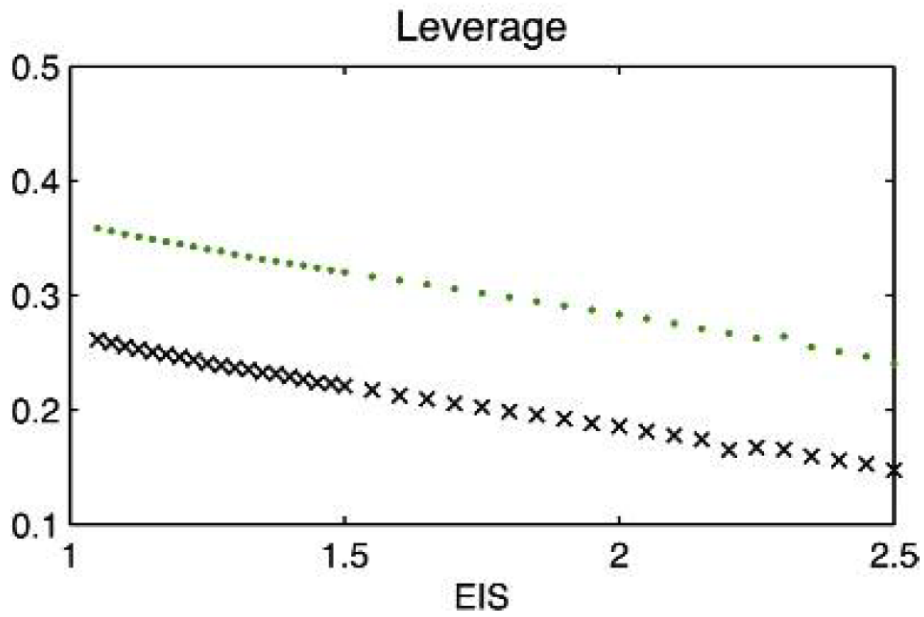
	Mean	Std. dev.
Real consumption growth	0.0333	0.0099
Real earnings growth	0.0343	0.1072

Panel B: Time-varying estimates

Parameter	Symbol	State 1	State 2
Consumption growth rate	g_i	0.0141	0.0420
Consumption growth volatility	$\sigma_{C,i}$	0.0114	0.0094
Earnings growth rate	θ_i	−0.0401	0.0782
Earnings growth volatility	$\sigma^s_{X,i}$	0.1334	0.0834
Correlation	ρ_{XC}	0.1998	0.1998
Actual long-run probabilities	f_i	0.3555	0.6445
Actual convergence rate to long-run	p	0.7646	0.7646
Annual discount rate	β	1%	1%
Tax rate	η	15%	15%
Bankruptcy costs	$1-\alpha_i$	30%	10%
Idiosyncratic earnings growth volatility	σ^{id}_X	0.2258	02258
Relative risk aversion	γ	10	10
Elasticity of intertemporal substitution	ψ	1.5	1.5
Issuance costs	ϕ_i	0.03	0.01

Theories of Macro and Capital Structure

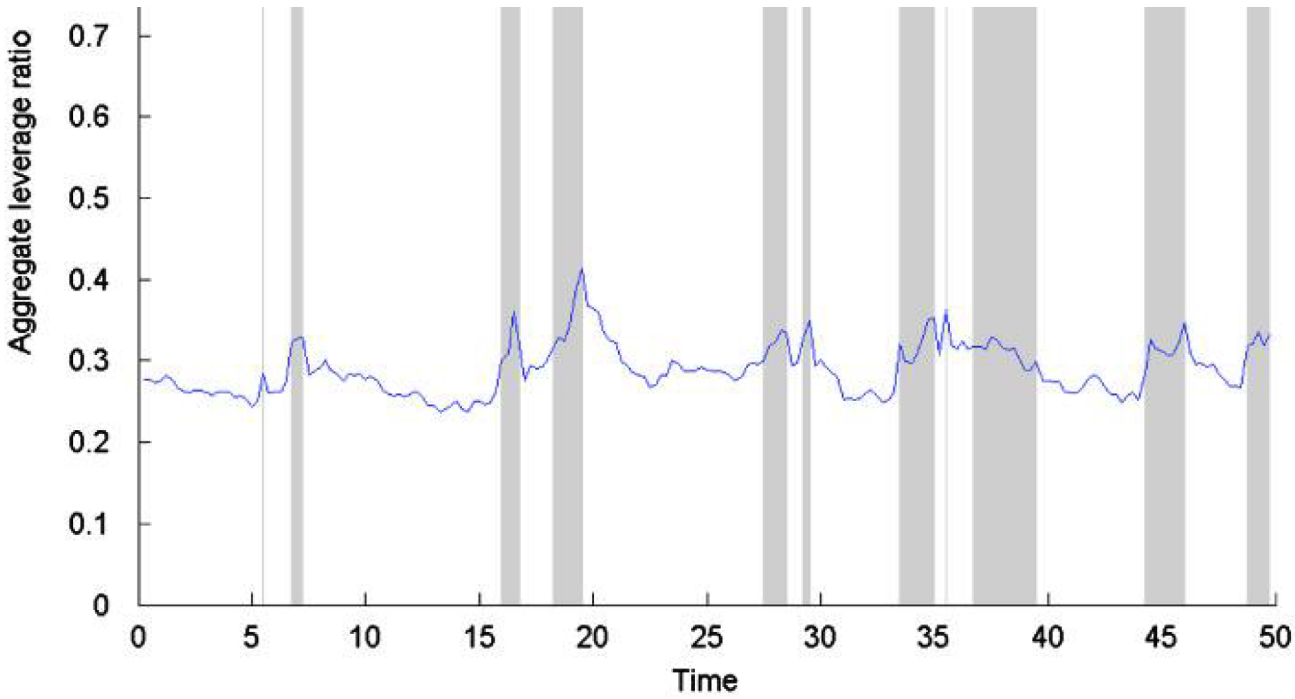




- Procyclical leverage at refinancing point.
- $\times$ represents the values for state 1, and ... represents the values for state 2

Theories of Macro and Capital Structure

- Aggregate dynamics of capital structure – strongly countercyclical leverage.



A Summary of Tradeoff Based Theories

- The changing in pricing kernel makes default more costly in bad state, so the leverage at refinancing point is procyclical.
- Equity value fluctuates much more than debt value, thus making the leverage strongly countercyclical on time average.
- Leverage is driven by many factors, and is not a good summary of preference information.
- Structural models have little predictions over equity issuance and debt issuance.

Empirical Studies

Leverage

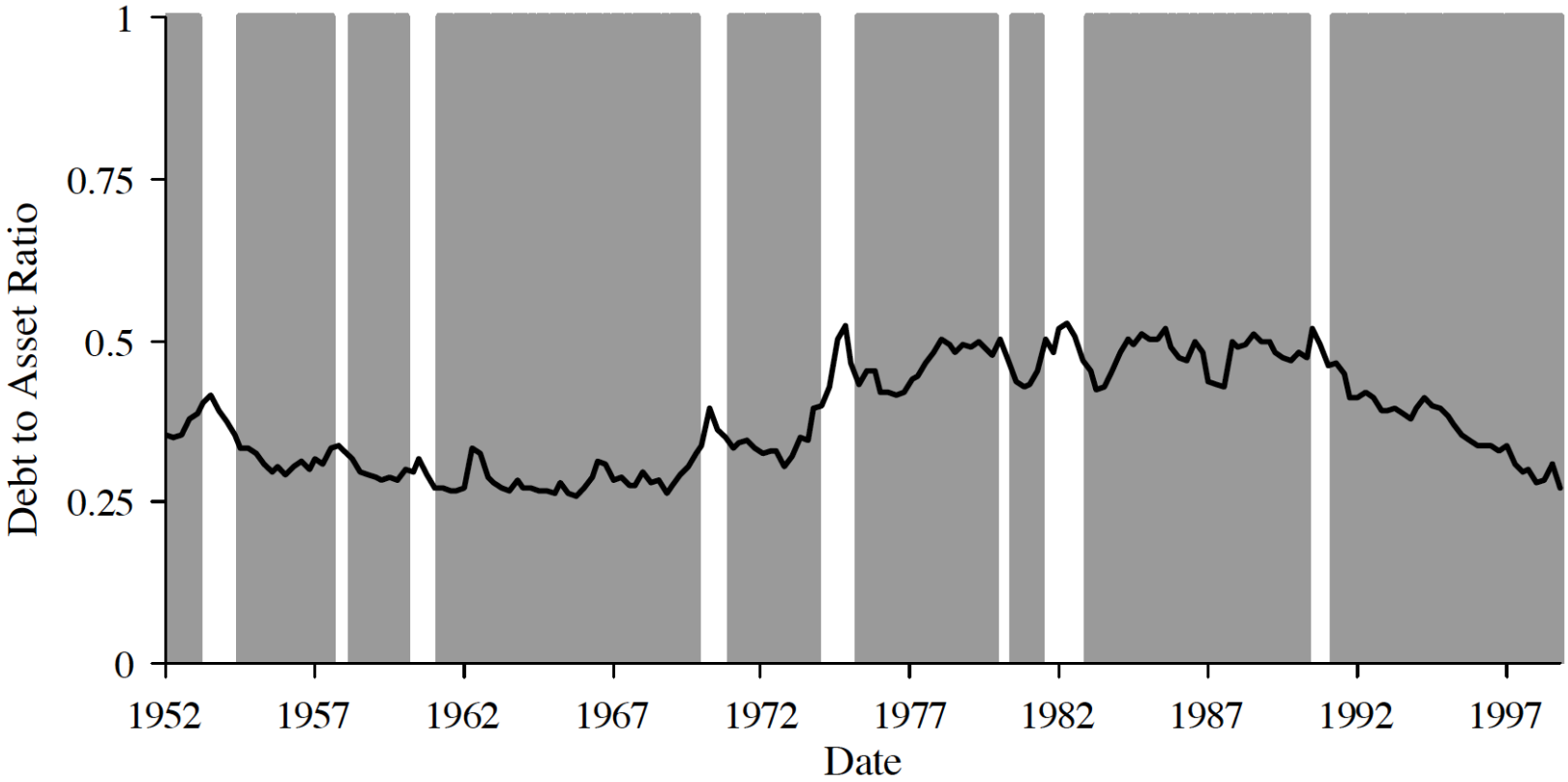


Fig. 1. Aggregate nonfinancial corporate debt to asset ratio across NBER expansions (shaded) and contractions (light). Debt to asset ratio is measured as the total credit instruments of nonfinancial corporations measured at book value, divided by the sum of credit market instruments and the market value of equity, as reported in Board of Governors of the Federal Reserve System, "Flow of Funds Accounts."

From [Korajczyk and Levy, 2003]

Leverage

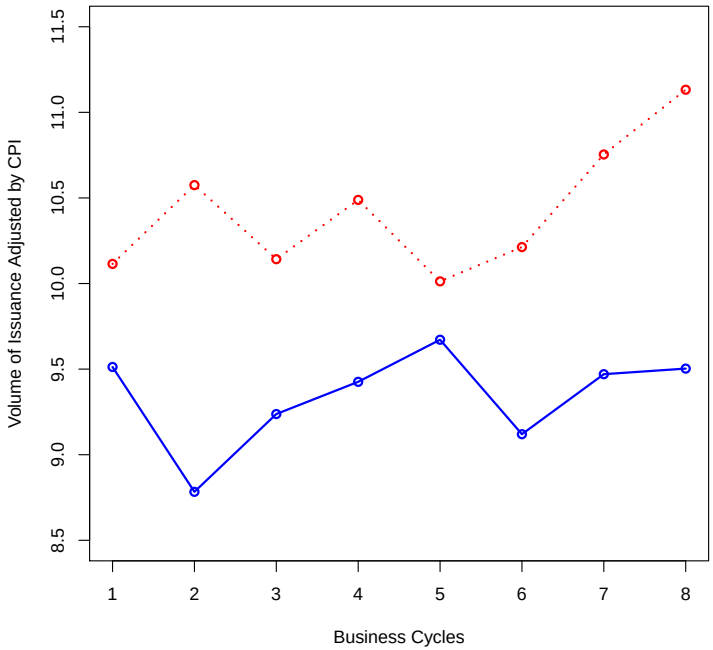
- Counter-cyclical for relatively unconstrained firms, but pro-cyclical (less significant) for the relatively constrained firms.

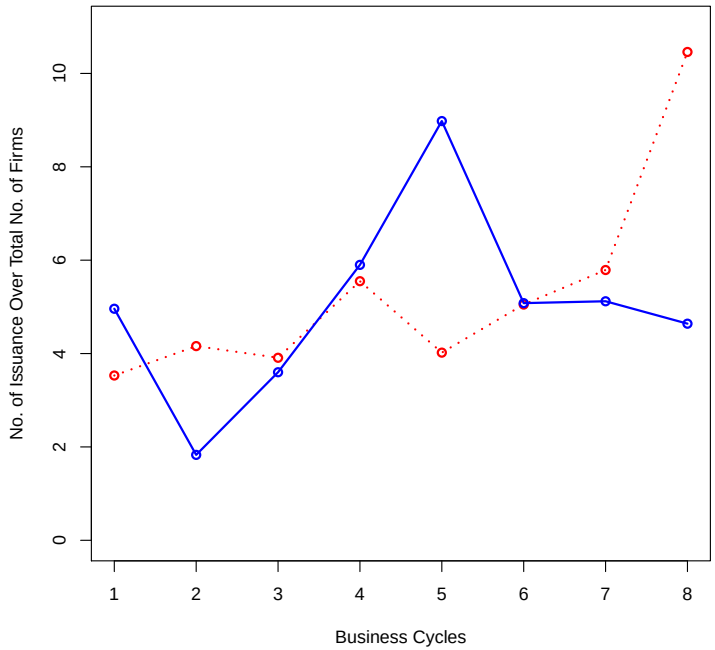
Lev	$\frac{\text{ST+LT Debt}}{\text{Market assets}}$	$\frac{\text{ST+LT Debt}}{\text{Market assets}}$	$\frac{\text{LT Debt}}{\text{Market assets}}$	$\frac{\text{ST+LT Debt}}{\text{Book assets}}$	$\frac{\text{ST+LT Debt−cash}}{\text{Market assets−cash}}$
Panel A: unconstrained firms					
2-year corp. profit growth	−0.083***	−0.106***	−0.044***	−0.062***	−0.035*
	(0.013)	(0.019)	(0.012)	(0.015)	(0.020)
2-year equity market return	−0.053***	−0.050***	−0.014**	−0.012**	−0.057***
	(0.007)	(0.009)	(0.006)	(0.008)	(0.010)
Commercial paper spread	3.585***	5.345***	1.547***	5.546***	3.349***
	(0.552)	(0.934)	(0.530)	(0.562)	(0.892)
Fixed effect	Firm	4 digit SIC	Firm	Firm	Firm
Number of obs.	45,443	45,443	45,443	45,443	44,882

From [Korajczyk and Levy, 2003]

Equity and Debt Issuance

- Countercyclical debt issuance and procyclical equity issuance.

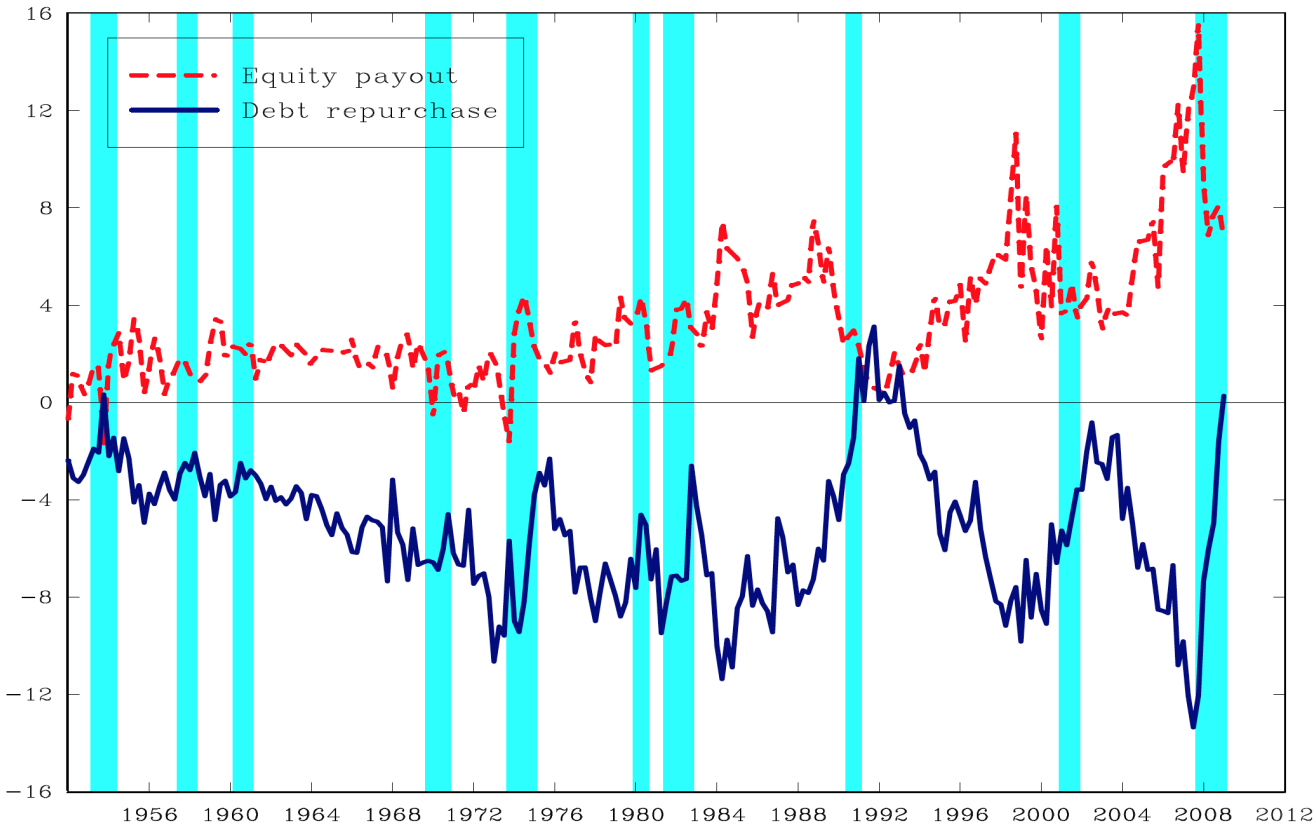




No. of issuance (left) and Adjusted Volume Over Business Cycles (Equity and Debt) from 1971-1991. The red dotted line is for debt and the blue solid line is for equity. Odd numbers in the x-axis mean upturns in business cycles and even numbers mean downturns. Data from [Choe et al., 1993].

Equity and Debt Issuance

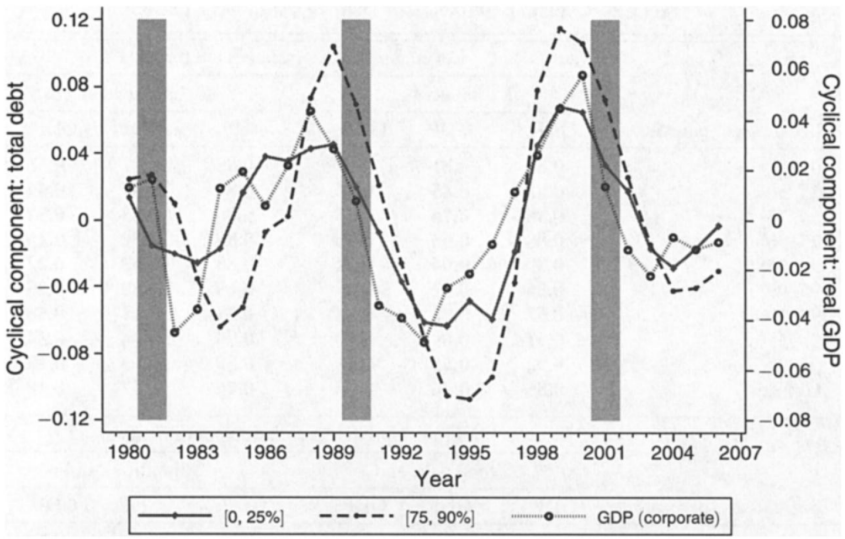
- Procyclical debt issuance and countercyclical equity issuance.

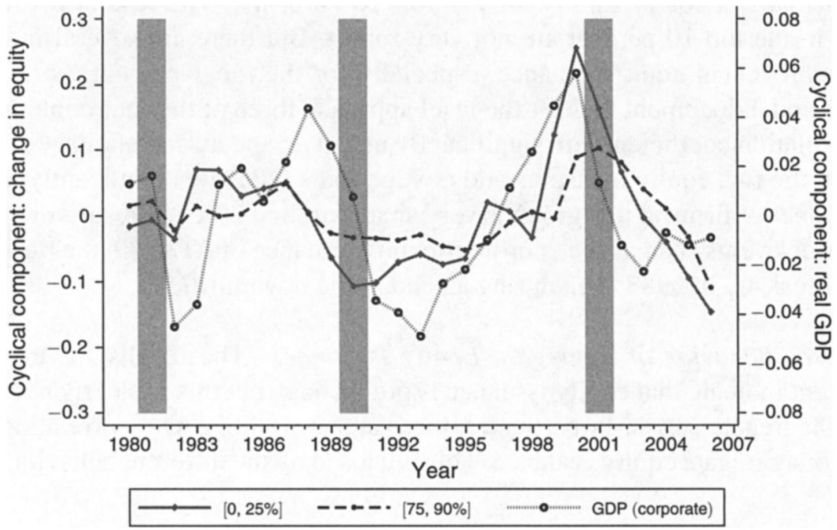


From [Jermann and Quadrini, 2006].

Equity and Debt Issuance

- Procyclical debt issuance and procyclical equity issuance.





From [Covas and Haan, 2011] and sorted by size.

Are Theory Papers Citing the Right Empirical Evidence?

- [Hackbarth et al., 2006] mentions that "the model predicts that market leverage should be countercyclical, consistent with the evidence reported by [Korajczyk and Levy, 2003]".
  - However, the "countercyclical leverage" in [Bhamra et al., 2010a] is the leverage at refinancing while in [Korajczyk and Levy, 2003] is the mean leverage.

A Summary of Empirical Studies

- There are very few papers on leverage cycles, and no paper distinguishing leverage at refinancing point and leverage of time average.
- Dramatically different results on equity and issuance.

Research Opportunities

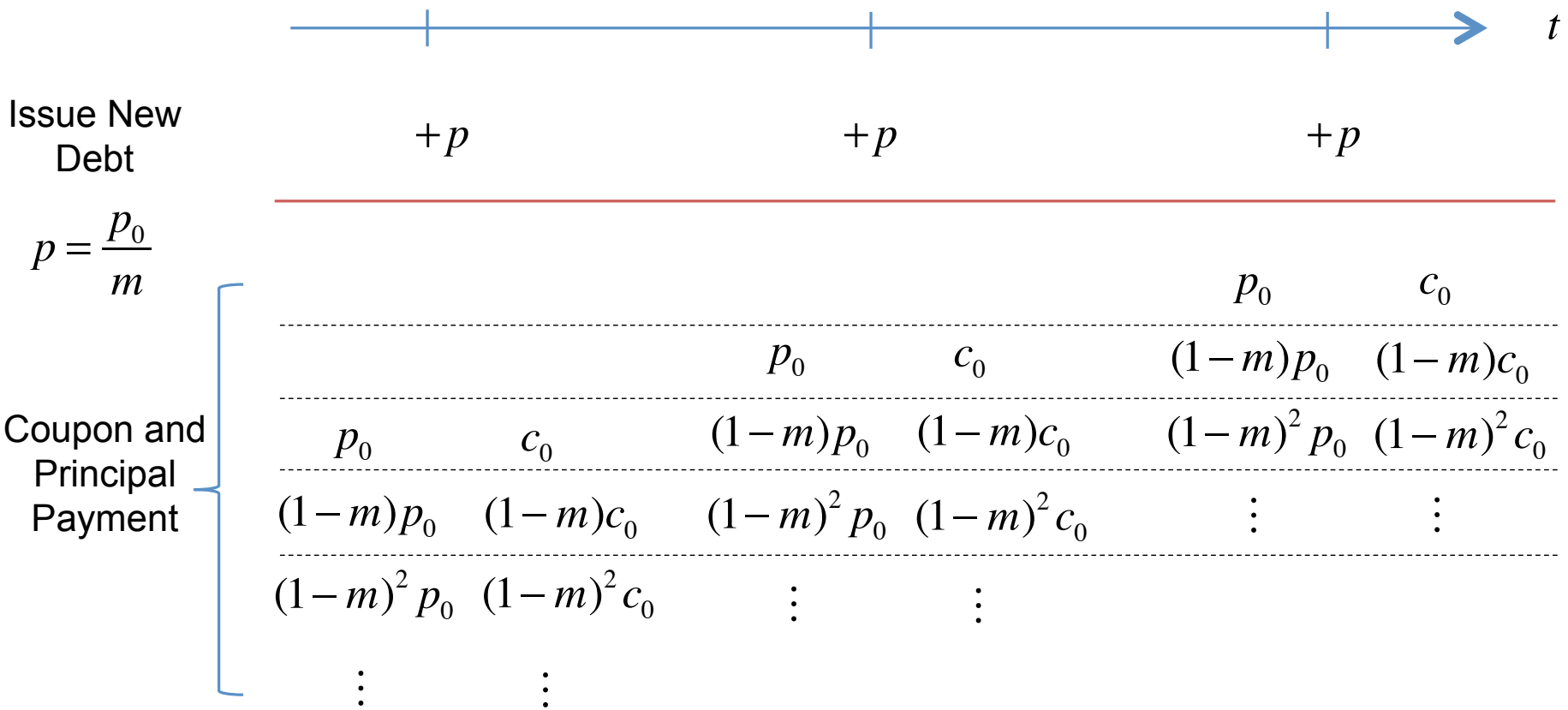
Possibilities for Future Research

- Theoretical Research
  - How does debt and equity issuance change across business cycles?
  - How does agency costs and asymmetric information influence capital structure across business cycles?
  - How is term structure of credit spreads influenced by business cycles (using the modeling trick of finite maturity debt and Epstein-Zin preference)?
- Empirical Research
  - Is there a big difference of leverage cyclicality at refinancing point and on time average, as predicted by [Chen, 2010], [Bhamra et al., 2010a], and [Bhamra et al., 2010b]?
  - Why there is a dramatic difference among previous research on debt and equity issuance?

Supplements

Finite Debt Maturity

Principal p, coupon $c = c_0/m$, and maturity $T = 1/m$



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