Real Investments and their Financing: the role of bond covenants in different types of industries

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A few Words on Bond Covenants

- Bond Covenants
  - Many different covenants
  - What role do they play?
  - Research on covenants
    - Empirically: New detailed databases
    - Theoretically: Almost nothing
  - This paper
    - Theoretical model
    - Continuous-time structural model of firms' future cash flows
    - How (in principle) to design optimal covenants
    - How should they vary with across industries

Our Research Question

- Does capital structure decisions (i.e., the financing of the firm) interrelate with (real) investments decisions?
  - Capital structure decisions before the investment
  - The timing of the investment decision itself
  - The financing of the investment
  - Why does capital structure influence investment decisions (Compare Myers, 1977)
  - Are there situations where it does not influence the real decisions? (Compare Modigliani and Miller, 1958, 1961, and 1963)
- How does/should capital structure and investments vary across different industries, competitive settings, and production technologies?
- How does the covenants of the debt contracts influence the investment decisions?

What are we doing?

- Providing a micro foundation to the Dynamic Capital Structure Models
- Making a role for investments
- Analyzing different competitive structures and different industries
  - monopoly, imperfect competition, perfect competition
  - mature versus growth industry
- Discuss covenants and introduce the concept of idealized (optimal?) covenants

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A Firms Capital Structure: the traditional approach

- Firm's cash flow

$$d\xi_t = \xi_t \mu dt + \xi_t \sigma dW_t$$

- Trade off between tax savings from coupon payments versus bankruptcy costs
- μ and σ are exogenous.
- No investments

The Firms Capital Structure Decision

- (Instantaneous) cash flow from the production unit, ξ_t
- Firm is financed by
  - Debt with fixed instantaneous coupon rate, c, and infinite maturity
  - Equity
- Cash flow to
  - Debt: $(1-\tau_c)c$
  - Equity: $(1-\tau_e)(\xi_t - c)$
  - An Investor who have invested in both debt and equity: $(1-\tau_e)\xi_t + (\tau_e - \tau_c)c$
- The curse of having debt: Bankruptcy
  - The equity holders have a real option to stop paying the coupons (the limited liability option). I.e., if ξ_t becomes too low relative to c the equity holders will exercise this option. Hence, there is a trigger value, ξ^B.

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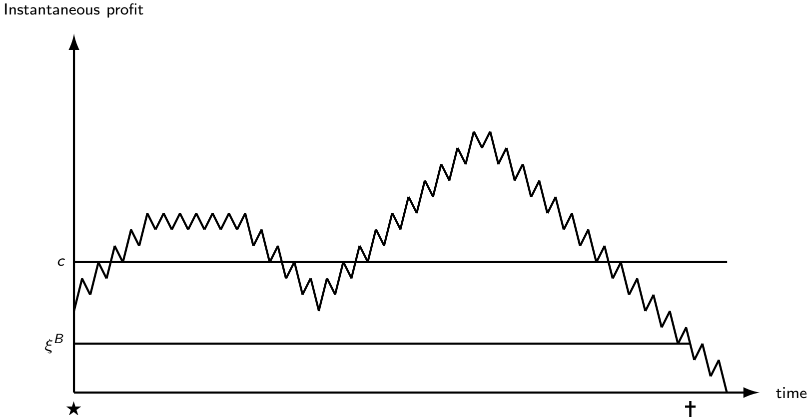
A Firms Capital Structure



A Micro Foundation

- The price of the product at a given quantity demanded, q

$$p(q) = aX_t^{\gamma} q^{-\theta}$$

where $a, \gamma > 0, 0 \leq \theta < 1$, and X is an exogenously specified income process

$$dX_t = X_t \mu dt + X_t \sigma dW_t, X_0 = 1$$

- Costs of producing a given quantity, q

$$C(q) = Kq^{\kappa}$$

Convex costs of producing, i.e. $\kappa > 1$. I.e, decreasing returns of scale

- Profit from producing q units

$$qp(q) - C(q) = aX_t^{\gamma} q^{1-\theta} - Kq^{\kappa}$$

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A Micro Foundation

- Instantaneous solutions $q^*(X_t)$
  - Monopoly: Use market power
  - Duopoly: Both competitors take price impact into account
    - Cournot competition
    - Bertrand competition
  - Perfect Competition: Price exogenously determined by X_t
- The instantaneous profit

$$\xi_t = \omega X_t^{\epsilon} K^{\eta}$$

  with $\epsilon > 0$, $\eta < 0$, and $\omega > 0$ determined by industry and competitive environment
- By Itô's Lemma
  - Firm's cash flow

$$d\xi_t = \xi_t \mu_\xi dt + \xi_t \sigma_\xi dW_t$$

  - μ_ξ and σ_ξ are determined by industry and competitive environment

A Micro Foundation

- The instantaneous profit in the monopoly and perfect competition cases

$$\xi_t = \omega X_t^{\epsilon} K^{\eta}$$

- Parameters

$$\epsilon = \frac{\gamma\kappa}{\kappa+\theta-1} > 0$$

$$\eta = -\frac{1-\theta}{\kappa+\theta-1} < 0$$

$$\omega = (1-\theta)^{\frac{1-\theta}{\kappa+\theta-1}} \left(\frac{a}{\kappa}\right)^{\frac{\kappa}{\kappa+\theta-1}} (\kappa+\theta-1) > 0$$

Investments and Bankruptcy

- An investment can reduce variable production costs, K
  - New approach (as far as we know)
  - Others have looked at capacity constraints: Numerically very complicated
- After a bankruptcy the variable production costs, K, may have increased

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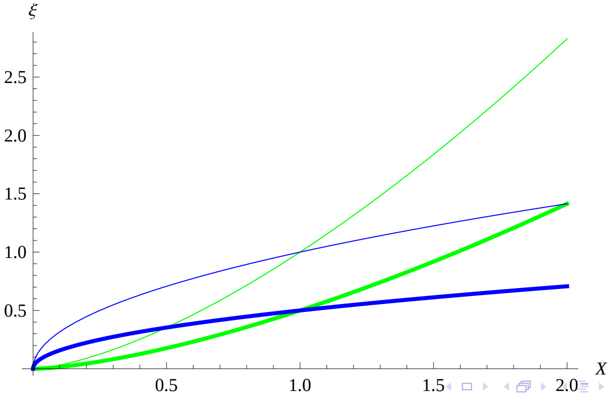
Different Competitive Settings and Different Industries

- Different types of industries
  - Competitive (low θ — and very low ω) versus non competitive (high θ — and not so low ω)
  - Mature (low γ) versus growth (high γ)
  - High versus low κ
  - Do not forget ω



Combining Investments and Capital Structure

- We have an option to improve the production
  - Invest I at a given date
  - After the investment the parameter in the optimal instantaneous cash flow, K,

$$\xi_t = \omega X_t^{\epsilon} K^{\eta}$$

  changes from K to fK, where $f < 1$
- The firm has already some debt in its capital structure with instantaneous coupon rate, c
- (Part of) the capital needed for the new investment, I, will be raised by issuing more debt in the firm (with instantaneous coupon rate, c_J)

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Combining Investments and Capital Structure

- We have to be careful with covenants of debt and with how to split the firm value in case of bankruptcy between the two classes of debt
  - No new debt (Myers covenants)
  - Absolute priority rule (APR) covenants
  - Our idealized covenants
- Typically, a firm has to default on all its debt at the same point in time.
- The decision to make the investment (and how to finance it) will be taken by the equity holders, i.e., maximizing their future cash flow

Combining Investments and Capital Structure

- What is happening?
  - Cash flows before the investment
    - Debt: $(1-\tau_c)c$
    - Equity: $(1-\tau_e)(\omega X_t^{\epsilon} K^{\eta} - c)$
  - Cash flows after the investment
    - Debt: $(1-\tau_c)(c + c_J)$
    - Equity: $(1-\tau_e)(\omega X_t^{\epsilon} (fK)^{\eta} - c - c_J)$
  - The capital raised by issuing the new debt helps the equity holders finance the new investment, I

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Combining Investments and Capital Structure

- A couple of (interesting) questions
  - Does it delay or accelerate the decision to make the investment that
    - there is already some debt in the firms original capital structure (delay)
    - that (part of) the investment capital, I, can be raised by issuing new debt? (accelerate)
  - Can we separate the effect of the two issues?
  - Does it change the *original* decision to issue debt in the firm that the firm has a (valuable) real option investment opportunity? (reduce initial debt for two reasons—(i) bankruptcy kills the investment option (ii) we get a second chance to increase debt)
  - And how does the answers to these questions depend on the covenants of the debt?

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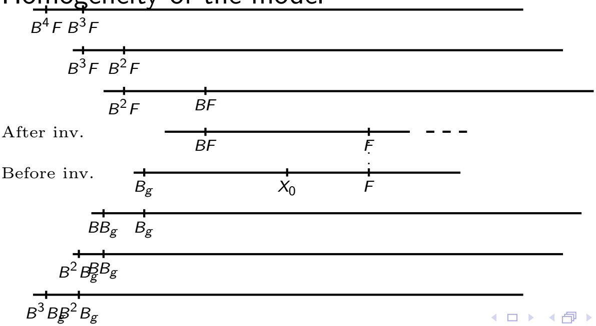
The Values of Debt and Equity

- Debt value $D(X; c, K)$ and equity value $E(X; c, K)$
- Coupon, c, is optimized initially (when $X = X_0$)

$$\max_c D(X_0; c, K) + E(X_0; c, K)$$

- Homogeneity of the model



The Boundary Conditions at Bankruptcy

- The boundary conditions at the bankruptcy trigger level, B_g

$$E(B_g; c, K) = 0$$
$$E'(B_g; c, K) = 0$$
$$D(B_g; c, K) = (1 - \alpha) A_m B_g^{\epsilon} (bK)^{\eta}$$

- α reflects direct bankruptcy costs
- $b > 1$ reflects indirect bankruptcy costs
- A_m is the value of a similar firm optimally financed but *without* the investment option (a *mature* firm
- The optimal coupon in this case, we denote c_m

$$c_m = \arg\max_c A_m$$

The Boundary Conditions at Investment: Myers Covenants

- The boundary conditions at the investment trigger level, F

$$E(F;c,K) = E_m(F;c,fK) - I$$
$$E'(F;c,K) = E_m'(F;c,fK)$$
$$D(F;c,K) = D_m(F;c,fK)$$

- D_m and E_m denote values of the mature firm (with no investment option).
- An alternative smooth pasting condition in order to implement first-best (firm value maximizing) investment decisions

$$D'(F;c,K) + E'(F;c,K) = D_m'(F;c,fK) + E_m'(F;c,fK)$$

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The Boundary Conditions at Investment: APR Covenants

- After investment, we will have two classes of debt, senior and junior
- The boundary conditions (after investment) at the bankruptcy trigger level, B_m

$$E_m(B_m; c_m, K) = 0$$
$$E'_m(B_m; c_m, K) = 0$$
$$D_m(B_m; c_m, K) = (1-\alpha)A_m B_m^{\epsilon}(bK)^{\eta}$$
$$D_{ms}(B_m; c, K, c_m) = \min\left\{(1-\alpha)A_m B_m^{\epsilon}(bK)^{\eta}, \frac{(1-\tau_c)c}{r}\right\}$$

- Determining the value of the junior debt

$$D_{mj}(X; c_j, K, c_m) = D_m(X; c_m, K) - D_{ms}(X; c_m - c_j, K, c_m)$$

The Boundary Conditions at Investment: APR Covenants

- The optimal coupon of the junior debt after the investment

$$c_m^*(X;c,K) = \arg\max_{c_m}\big(D_{mj}(X;c_m - c, K, c_m) + E_m(X;c_m,K)\big)$$

- The boundary conditions at the investment trigger level, F

$$E(F;c,K) = D_{mj}(F;c_m^*(F;c,fK) - c, fK, c_m^*(F;c,fK)) + E_m(F;c_m^*(F;c,fK),fK) - I$$

$$E'(F;c,K) = \frac{d}{dF}\left(D_{mj}(F;c_m^*(F;c,fK) - c, fK, c_m^*(F;c,fK)) + E_m(F;c_m^*(F;c,fK),fK)\right)$$

$$D(F;c,K) = D_{ms}(F;c,fK,c_m^*(F;c,fK))$$

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The Boundary Conditions at Investment: APR Covenants

- Rewriting the boundary conditions at the investment trigger level, F

$$
\begin{aligned}
E(F; c, K) &= D_m(F; c^*_m(F; c, fK), fK) + E_m(F; c^*_m(F; c, fK), fK) \\
&\quad - D_{ms}(F; c, fK, c^*_m(F; c, fK)) - I \\
E'(F; c, K) &= D'_m(F; c^*_m(F; c, fK), fK) + E'_m(F; c^*_m(F; c, fK), fK) \\
&\quad - D'_{ms}(F; c, fK, c^*_m(F; c, fK)) \\
D(F; c, K) &= D_{ms}(F; c, fK, c^*_m(F; c, fK))
\end{aligned}
$$

- The smooth pasting condition for first-best investment decisions is

$$D'(F; c, K) + E'(F; c, K) = D'_m(F; c^*_m(F; c, fK), fK) + E'_m(F; c^*_m(F; c, fK), fK)$$

- ...which can be rewritten as

$$E'(F; c, K) = D'_m(F; c^*_m(F; c, fK), fK) + E'_m(F; c^*_m(F; c, fK), fK) - D'(F; c, K)$$

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The Boundary Conditions at Investment: APR Covenants

- Hence, it is in the equity holders own interest to implement first best investment decisions when

$$D'(X; c, K) = D'_{ms}(X; c, fK, c^*_m(X; c, fK))$$

for all potential investment triggers, X

- Design covenants so this will be the case

The Boundary Conditions at Investment: Idealized Covenants

- The value of the senior debt

$$D(X;c,K) = d_1(c,K)X^{x_1} + d_2(c,K)X^{x_2} + \frac{(1-\tau_c)c}{r}$$

- Assume $d_1(c,K) = 0$ instead of having a value matching condition for debt at the investment trigger, F
- Economic interpretation: This is what bond covenants ideally should achieve

The Boundary Conditions at Investment: Idealized Covenants

- The optimal coupon of the junior debt after the investment

$$c_m^*(X; c, fK) = \arg\max_{c_m}\big(D_m(X; c_m, fK) + E_m(X; c_m, fK) - D(X; c, K)\big)$$
$$= \arg\max_{c_m}\big(D_m(X; c_m, fK) + E_m(X; c_m, fK)\big) = \bar{c}_m X^{\epsilon}(fK)^{\eta}$$

- The boundary conditions at the investment trigger level, F

$$E(F; c, K) = A_m F^{\epsilon}(fK)^{\eta} - D(F; c, K) - I$$
$$E'(F; c, K) = \epsilon A_m F^{\epsilon-1}(fK)^{\eta} - D'(F; c, K)$$

- Equity holders choice of investment trigger using idealized covenants is first best

$$D'(F; c, K) + E'(F; c, K) = \epsilon A_m F^{\epsilon-1}(fK)^{\eta}$$

- Total coupon rate (determined by equity holders) is identical to the coupon rate that maximizes total firm value after investment

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Example: a firm with an investment option (real option)

- Current Earnings: $X = 1$
- Current Value: $A = 15$
- Current Capital Structure
  - Equity value: $E = 10$
  - Debt value: $D = 5$
  - Coupon: $c = 0.5$
- The investment option
  - Invest $I = 25$ (i.e. improve production facility)
  - The earnings at each instant in time will be doubled
  - The endogenously determined trigger for when to exercise the option is $X_I = F = 3$

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Example: a firm with an investment option (real option)

- The (optimal) situation just after the investment option is exercised:
  - Earnings: $2X_I = 6$
  - Value: $A_+ = 55$
  - Capital Structure
    - Equity value: $E_+ = 28$
    - Debt value: $D_+ = 27$
    - Coupon: $c_+ = 2.0$
- The situation just before the investment option is exercised:
  - Earnings: $X_I = 3$
  - Value: $A = A_+ - I = 30$
  - Capital Structure
    - Coupon: $c = 0.5$
    - Debt value: $D = 9$
    - Equity value: $E = A - D = 21$

Example: a firm with an investment option (real option)

- How to finance the new investment (at the trigger point, $X_I = 3$)?
  - New debt (assume we approach the same creditors):
    - Coupon of junior debt: $c_J = c_+ - c = 1.5$
    - Value of junior debt: $D_J = D_+ - D = 18$
  - New equity: $E_J = I - D_J = 7$
- Hence, the situation just after the investment option is exercised:
  - Earnings: $X = 6$
  - Capital Structure
    - Equity value: $E + E_J = 28$
    - Debt value: $D + D_J = 27$
    - Coupon: $c + c_J = 2.0$
  - Value: $A = E + E_J + D + D_J = 55$

Parameter Values

- Short term (after-tax) interest rate $r = 0.05$
- Volatility on the X process $\sigma = 0.1$
- Drift of the X process $\mu = 0.005$
- Price elasticity of demand $\theta = 0$
- Income elasticity of demand $\gamma = 1$
- Convexity of cost function $\kappa = 2$
- Direct bankruptcy cost $\alpha = 0.1$
- Indirect bankruptcy costs $b = 1.1$
- The effective tax rate on dividends $\tau_e = 0.4$
- The tax rate on coupon payments $\tau_c = 0.3$
- Improvement from investment $f = 0.6$
- Investment costs $I = 2$

Some Numbers

Base case ($\epsilon = 2$, $\eta = -1$, $\omega = 0.25$):

	Pure E No inv No refi	$E\&D$ No inv No refi		$E\&D$ No inv APR	$E\&D$ No inv FB APR	$E\&D$ No inv Ideal cov
Firm value	5.000	5.362		5.460	5.461	5.462
Bankruptcy trigger	-	0.659		0.630	0.630	0.630
Refinancing trigger	-	-		2.129	1.941	1.943
Initial leverage	-	65.96		61.42	61.38	61.33
Credit spread, basis points	-	84.1		72.0	71.2	72.5

	Pure E Inv No refi	$E\&D$ Inv No refi	$E\&D$ FB inv No refi	$E\&D$ Inv APR	$E\&D$ FB inv FB APR	$E\&D$ (FB) Inv Ideal cov
Firm value	6.586	6.976	6.987	7.189	7.195	7.196
Bankruptcy trigger	-	0.617	0.631	0.521	0.535	0.538
Investment/Refin trigger	1.278	1.315	1.221	1.330	1.276	1.278
Initial leverage	-	55.49	57.90	40.58	42.87	42.66
Credit spread, basis points	-	71.1	72.6	35.3	36.4	48.1

Some Numbers

Base case ($\epsilon = 2$, $\eta = -1$, $\omega = 0.25$):

	Pure *E* No inv No refi	*E&D* No inv No refi		*E&D* No inv APR	*E&D* No inv FB APR	*E&D* No inv Ideal cov
Initial leverage	-	65.96		61.42	61.38	61.33
Credit spread, basis points	-	84.1		72.0	71.2	72.5
Lev just before refinancing	-	-		15.78	18.95	18.66
Credit spr just before refin	-	-		0.0	0.0	7.9
Lev just after refin	-	-		65.96	65.96	65.96
Credit spr of senior debt	-	-		0.0	0.0	7.9
Credit spr of junior debt	-	-		98.2	101.7	99.7
	Pure *E* Inv No refi	*E&D* Inv No refi	*E&D* FB inv No refi	*E&D* Inv APR	*E&D* FB inv FB APR	*E&D* (FB) Inv Ideal cov
Initial leverage	-	55.49	57.90	40.58	42.87	42.66
Credit spread, basis points	-	71.1	72.6	35.3	36.4	48.1
Lev just before refinancing	-	33.00	40.35	22.62	26.35	25.66
Credit spr just before refin	-	15.5	21.3	0.0	0.0	21.1
Lev just after refin	-	28.60	34.15	65.96	65.96	65.96
Credit spr of senior debt	-	15.5	21.3	0.0	0.0	21.1
Credit spr of junior debt	-	-	-	120.1	128.4	116.0

Some Numbers

Base case ($\epsilon = 2$, $\eta = -1$, $\omega = 0.25$):

	Pure *E* No inv No refi	*E&D* No inv No refi		*E&D* No inv APR	*E&D* No inv FB APR	*E&D* No inv Ideal cov
Asset beta	2.000	2.000		2.000	2.000	2.000
Equity beta	2.000	4.844		4.448	4.441	4.444
Debt beta	-	0.532		0.463	0.464	0.459

	Pure *E* Inv No refi	*E&D* Inv No refi	*E&D* FB inv No refi	*E&D* Inv APR	*E&D* FB inv FB APR	*E&D* (FB) Inv Ideal cov
Asset beta	2.280	2.283	2.303	2.253	2.257	2.257
Equity beta	2.280	4.465	4.642	3.579	3.684	3.710
Debt beta	-	0.53	0.602	0.311	0.356	0.304

Some Empirical Implications

- (Initial) leverage ratios depend on
  - Industry: More growth, less leverage
  - Competitiveness: More competitive, less leverage
  - Convexity of costs: ambiguous
  - Moneyness of real investment option(s): more in-the-money, less leverage
- Investment triggers
- Bankruptcy triggers
- In order to implement first best decisions of investments a rich menu of debt covenants to pick from is essential in designing debt contracts

Why are we doing this?

- Investment (and bankruptcy) behavior and the competitive environment
- How does capital structure influence investment decisions (Compare Myers, 1977)
- How taxes influence investments (and bankruptcy) across different industries
- Analyzing bankruptcy treatment
- Return requirements for different types of (optimal) financing of investments
- A rigorous treatment of Weighted Average Cost of Capital (WACC)
- Separation between direct and indirect bankruptcy costs
- Only one investment option per firm (Will be lost in case of bankruptcy before investment option is exercised)

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With Competitive Interactions

- So far we have to force firms to have 100% equity financing after bankruptcy
- A leader (who invests first) and a follower
- Preemption for some parameter values
- A new role for debt: To reduce preemption

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The Big(ger) Picture

- Does the insights from this model relate to the financial crisis?
  - Real options investment are pro cyclical
  - Debt financing may reduce or increase the pro cyclicallity—but in most realistic cases it actually reduces it
  - Would automatically converted debt help?
    - Ex post: YES
    - But ex ante: NO
  - What would help?

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