

Fall 2008, Hitotsubashi University
Monetary Economics 1
(Corporate Finance)

LECTURE 4
**MM theorem and
the Calculation of WACC**

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11/10/2008

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FORMAL DISCUSSION OF MM

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Modigliani-Miller theorem

- Foundation of Modern Corporate Finance
- Referred as “MM” hereafter
- Corporate Finance Doesn't Matter!

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Exactly, MM theorem says

- Proposition 1
 - Capital structure is irrelevant as long as the firm's investment decisions are taken as given.

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Little more precisely,

- Proposition 1: If
 - No taxes/transaction costs
 - Efficient Capital Markets
 - No bankruptcy costs
- Then, the value of the firm is independent from its capital structure.
 - e.g., debt–equity ratio, dividend policy, and etc.

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Example: Tsukuba Corporation, no debt
 Share price is 1 million yen
 Total value 100 million yen (100 shares)

	GREAT	GOOD	OK	BAD
EBIT	20	15	10	5
#of shares	100	100	100	100
EPS	0.2	0.15	0.10	0.05
ROE	20%	15%	10%	5%

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Scenario 1

Tsukuba Co. repurchased a half of its own shares
by borrowing: interest rate 10%

	GREAT	GOOD	OK	BAD
EBIT	20	15	10	5
Interest	5	5	5	5
EAIT	15	10	5	0
#of shares	50	50	50	50
EPS	0.3	0.2	0.1	0
ROE	30%	20%	10%	0%

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Scenario 2:

Investor X borrowed 0.1million yen at interest
rate=10% and bought one share of Tsukuba Co.

	GREAT	GOOD	OK	BAD
EBIT	20	15	10	5
Share Payoff	0.4	0.3	0.2	0.1
Interest	0.1	0.1	0.1	0.1
Net profits	0.3	0.2	0.1	0

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ROE is same for Scenario 1 and 2

- Two ways to understand proposition 1
- Value additivity
- Arbitrage

- Cost of capital is independent from the amount of the firm's leverage.

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LET'S GO BACK TO WACC

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Implications for cost of capital (Discount rate for the firm's business)

$$r_c = \left(\frac{E}{E + D} \right) r_E + \left(\frac{D}{E + D} \right) i$$

- Firm's cost of capital =
 "Ratio of equity finance" x "Equity cost of capital"
 + "Ratio of debt finance" x "interest rate on debt"

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Timberland Co.'s cost of capital

- Timberland Co.'s debt and equity

	Book value		Market value	
	Amount	Shares	Amount	Shares
Debt	100.0	27.3%	100.0	16.5%
Equity	266.2	72.7%	505.7	83.5%
Total	366.2	100.0%	605.7	100.0%

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Timberland Co.'s debt

- Yield of Timberland Co.'s corporate bonds: 7%
- Exemption of corporate tax for interest rate payment
- Corporate tax rate: 35%
- $(1 - 0.35) \times 0.07 = 0.046$
- $r_{\text{debt}} = (1 - \tau) \times r$

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Timberland Co.'s equity

- Use CAPM to calculate equity premium
- $r_{\text{stock}} = \text{JGB rate} + \text{risk premium}$
 $= \text{JGB rate}$
 $+ \beta \times \text{risk premium on market portfolio}$
- $\beta = 1.49$
- $r_{\text{stock}} = 5.1\% + 1.49 \times 7.5\% = 16.3\%$

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Timberland Co.'s WACC

	Amount	Shares	After tax cost	Weighted cost
Debt	100.0	16.5%	4.6%	0.8%
Equity	505.7	83.5%	16.3%	13.6%
WACC				14.4%

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Cost of equity financing > cost of debt financing

- Is it possible to decrease the firm's cost of capital by increasing debt financing and decreasing equity financing?
- (If MM holds) **No!**
- When capital structure changes, riskiness of equity will change too, i.e. β will change.
- As long as MM theorem holds, the firm's cost of capital will not change.

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$$\sigma_{Firm} = \left(\frac{D}{D+E} \right) \sigma_{Debt} + \left(\frac{E}{D+E} \right) \sigma_{Stock}$$

$$\beta_{Firm} = \left(\frac{D}{D+E} \right) \beta_{Debt} + \left(\frac{E}{D+E} \right) \beta_{Stock}$$

But, beta for debt is zero. So reversing these relations, we have

$$\sigma_{Stock} = \left(1 + \frac{D}{E} \right) \sigma_{Firm}$$

$$\beta_{Stock} = \left(1 + \frac{D}{E} \right) \beta_{Firm}$$

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Relaxing the assumptions of MM

- Exemption of corporate tax on interest rate payment
- 100% debt financing is optimal
- The possibility of bankruptcy
- 100% equity financing is optimal

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With bankruptcy risk

- Debt ratio: $D/(D+E)$
- $D/(D+E) \rightarrow 0 \quad \beta_{Stock} \rightarrow \beta_{Firm}$
- $D/(D+E) \rightarrow 1$: Beyond the threshold level, the probability of bankruptcy will be positive and beta for debt will be positive.

$$\beta_{Firm} = \left(\frac{D}{D+E} \right) \beta_{Debt} + \left(\frac{E}{D+E} \right) \beta_{Stock}$$

$$\beta_{Stock} = \left(1 + \frac{D}{E} \right) \beta_{Firm} + \left(\frac{D}{E} \right) \beta_{Debt}$$

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MM定理をどう解釈するか?

- MMは、現実経済の優れた記述ではない。しかし、なぜ資本構成が影響を与えるかについて分析する際のベンチマークとして重要。
 - ガリレオ: 『真空』での物体の落下
 - 完全競争と厚生経済学の基本定理
 - バロー＝リカードの等価命題

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MMの仮定を緩める

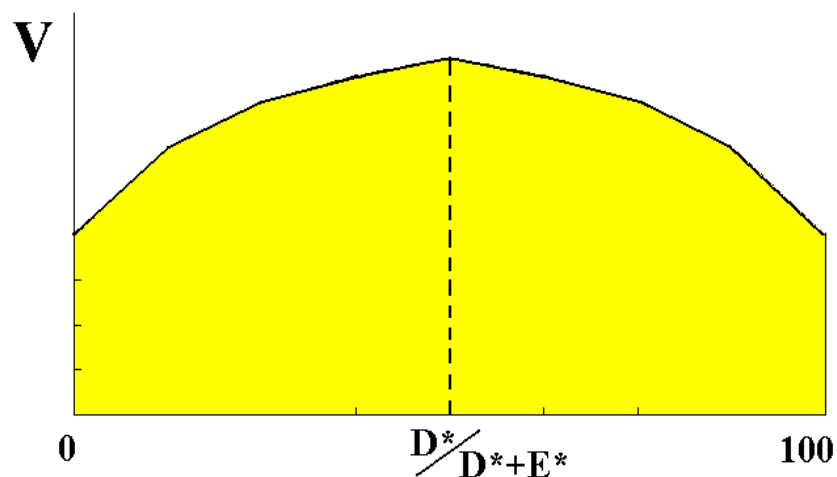
- 法人税の存在：
 - 利子支払いには課税されない
 - 最適資本構成 = 100%負債
- 倒産可能性のコスト
 - 多過ぎる借入れは、倒産の可能性を生む。
 - 負債は少なければ、少ない方が良い。

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静的トレードオフ理論 (Static Tradeoff Theory)



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実証上の問題

- 同じようなリスクに直面している企業でも、負債の割合には大きな差がある。
- 国別の負債割合の違いを説明できるか？
- 法人税率の改正