Cost of Capital

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Finance Theory II
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What Next?

- We want to value a project that is financed by both debt and equity

- Our approach:
  - Calculate expected ***Free Cash Flows*** (FCFs) from the project
  - Discount FCFs at a rate that reflects opportunity costs of capital of all capital suppliers
  - Incorporate the interest tax shields
    - Adjust the discount rate (WACC)
    - Adjust cash flows (APV)

Recall: ***Free Cash Flows*** are cash flows available to be paid to all capital suppliers ignoring interest rate tax shields (i.e., as if the project were 100% equity financed).

Two Approaches

- **Weighted Average Cost of Capital (WACC):**
  - Discount the FCF using the weighted average of after-tax debt costs and equity costs

$$\text{WACC} = k_D(1-t)\frac{D}{D+E} + k_E\frac{E}{D+E}$$

- **Adjusted Present Value (APV):**
  - Value the project as if it were all-equity financed
  - Add the PV of the **tax shield** of debt and other side effects

1. WACC

Weighted Average Cost of Capital (WACC)

- Step 1: Generate the Free Cash Flows (FCFs)
- Step 2: Discount the FCFs using the WACC

$$\text{WACC} = k_D(1-t)\frac{D}{D+E} + k_E\frac{E}{D+E}$$

WACC - Example

You are evaluating a new project. The project requires an initial outlay of \$100 million and you forecast before-tax profits of \$25 million in perpetuity. The tax rate is 40%, the firm has a target debt-to-value ratio of 25%, the interest rate on the firm's debt is 7%, and the cost of equity is 12%.

After-tax CFs = \$25 × 0.60 = \$15 million

$$\text{After-tax WACC} = D/V\ (1-\tau)\ r_d \ + \ E/V\ r_e$$

$$= 0.25 \times 0.60 \times 0.07 \ + \ 0.75 \times 0.12 = 10.05\%$$

NPV = -100 + 15 / 0.1005 = \$49.25 million

WARNING!!!

- The common intuition for using WACC is:
  - “To be valuable, a project should return more than what it costs us to raise the necessary financing, i.e., our WACC”
  - This intuition is wrong.

- Using WACC this way is OK sometimes... but “by accident”.
- Sometimes, this is plain wrong:
  - conceptually, i.e., the logic may be flawed
  - practically, i.e., gives you a result far off the mark

- Need to understand this concept (more tricky than it appears).

Weighted Average Cost of Capital (WACC)

- Recall: **Discount rates are project-specific** ==> Imagine the project is a stand alone, i.e., financed as a separate firm.
- Debt worth D (i.e. market value) and with expected return k_D (i.e., cost of debt) if against that project only
- Equity worth E (i.e. market value) and with expected return k_E (i.e., cost of equity) if against that project only
- t is the marginal tax rate of the firm undertaking the project

Why WACC?

- Consider a one-year project (stand-alone) such that:
  - expected cash-flow at the end of year 1 (BIT) = X
- Today (year 0) the projects has:
  - debt outstanding with market value D_0
  - equity outstanding with market value E_0
  - project's total value is $V_0 = D_0 + E_0$
- We are looking for the discount rate r such that:

$$V_0 = \frac{\text{Aftertax CFs (if all equity financed)}}{1+r} = \frac{(1-t)X_1}{1+r}$$

$$\boxed{r = \frac{(1-t)X_1 - V_0}{V_0}}$$

Why WACC? (cont.)

The expected increase in value from year 0 to year 1 is:

$$k_D D_0 + k_E E_0 = \boxed{\underbrace{k_D D_0}_{\text{CF to debt-holders}} + \underbrace{(1-t)(X_1 - k_D D_0)}_{\text{CF to share-holders}} - V_0}$$

$$k_E E_0 + (1-t)k_D D_0 = (1-t)X_1 - V_0$$

$$\underbrace{k_E \frac{E_0}{V_0} + (1-t)k_D \frac{D_0}{V_0}}_{\mathbf{r = WACC}} = \boxed{\frac{(1-t)X_1 - V_0}{V_0}}$$

Leverage Ratio D/(D+E)

- D/(D+E) should be the target capital structure (in market values) for the particular project under consideration.

- Common mistake 1:
  - Using a priori D/(D+E) of the firm undertaking the project.

- Common mistake 2:
  - Use D/(D+E) of the project's financing
  - Example: Using 100% if project is all debt financed.

Caveat: We will assume that the target for A+B is the result of combining target for A and target for B. It's OK most of the time.

Leverage Ratio (cont.)

- So how do we get that ratio?
- Comparables to the project:
  - “Pure plays” in the same business as the project
  - Trade-off: Number vs. “quality” of comps
- The firm undertaking the project if the project is very much like the rest of the firm (i.e., if the firm is a comp for the project).
- Introspection, improved by checklist,...

Important Remark

- If the project maintains a relatively stable D/V over time, then WACC is also stable over time.
- If not, then WACC should vary over time as well so you should compute/forecast a different WACC for each year.
- In practice, firms tend to use a constant WACC.
- So, in practice, WACC method is not great when capital structure is expected to vary substantially over time.

Cost of Debt Capital: k_D

- When default probability is low
  - We can estimate k_D using CAPM (empirical evidence suggests using debt betas between 0.2 and 0.3)
  - k_D should be close to the interest rate that lenders would charge to finance the project with the chosen capital structure

- When default probability is high
  - We would need default probabilities to estimate expected cash flows to debtholders

Marginal Tax Rate: t

- It’s the marginal tax rate of the firm undertaking the project (or to be more precise, of the firm + project).
- Indeed, this is the rate that is going to determine the tax savings associated with debt.
- Marginal as opposed to average tax rate t

Cost of Equity Capital: k_E

- Need to estimate k_E from comparables to the project:
  - “Pure Plays”, i.e. firms operating only in the project’s industry
  - The firm undertaking the project (if the firm is a pure play)

- Problem:
  - A firm’s capital structure has an impact on k_E
  - Unless we have comparables with same capital structure, we need to work on their k_E before using it.

Using CAPM to Estimate k_E

1) Finds comps for the project under consideration.

2) **Unlever** each comp's β_E (**using the comp's D/(D+E)**) to estimate its β_A:

$$\boxed{\beta_A = \frac{E}{V}\beta_E + \frac{D}{V}\beta_D}$$

3) Use the comps' β_A to estimate the project's β_A (e.g. take the average).

4) **Relever** the project's estimated β_A (**using the project's D/(D+E)**) to estimate its β_E under the assumed capital structure:

$$\boxed{\beta_E = \beta_A + \frac{D}{E}(\beta_A - \beta_D)}$$

5) Use the estimated β_E to calculate the project's cost of equity k_E:

$$\mathbf{k_E = r_f + \beta_E * \text{Market Risk Premium}}$$

Remarks

- Formulas:
  - Relevering formulas are reversed unlevering formulas.
  - The appendix shows where they come from.

- Most of the time:
  - Unlever each comp, i.e., one unlevering per comp.
  - Estimate one β_A by taking the average over all comps' β_A possibly putting more weight on those we like best.
  - This is our estimate of the project's β_A
  - Relever that β_A only, i.e., just one relevering.

- In the course, we use mostly the formula for a constant D/V.

More on Business Risk and Financial Risk

- Comparable firms have similar ***Business Risk***
  - ➔ Similar asset beta β_A and, consequently, similar unlevered cost of capital k_A
- Comparable firms can have different ***Financial Risk*** (β_E-β_A) if they have different capital structures
  - ➔ Different equity beta β_E and thus different required return on equity k_E
- In general, equity beta β_E increases with D/E
  - ➔ Consequently the cost of equity k_E increases with leverage

Leverage, returns, and risk

Asset risk is determined by the type of projects, not how the projects are financed

- Changes in leverage do not affect r_A or β_A
- Leverage affects r_E and β_E

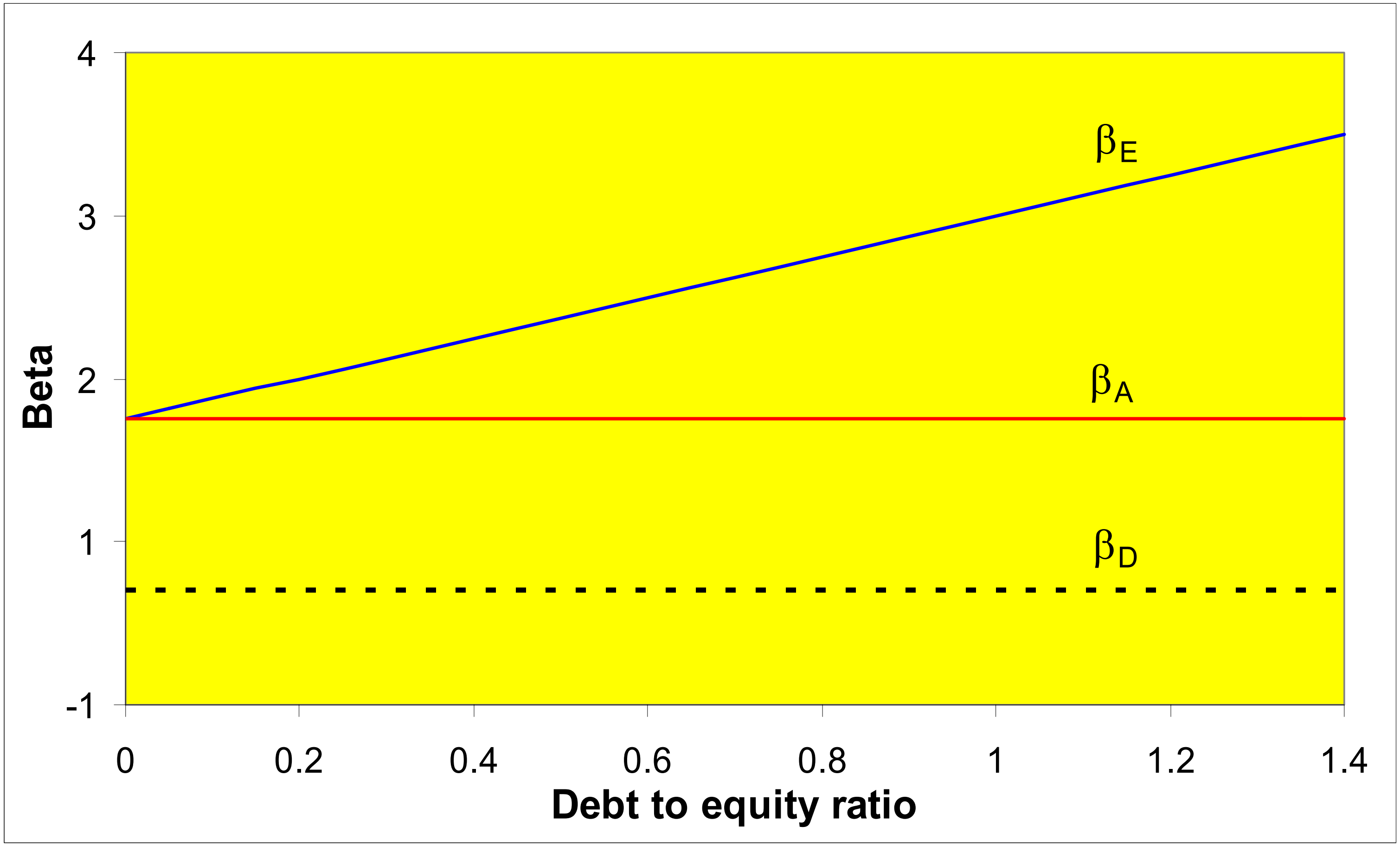
$$\beta_A = \frac{D}{V}\beta_D + \frac{E}{V}\beta_E$$

$$\beta_E = \beta_A + \frac{D}{E}(\beta_A - \beta_D)$$

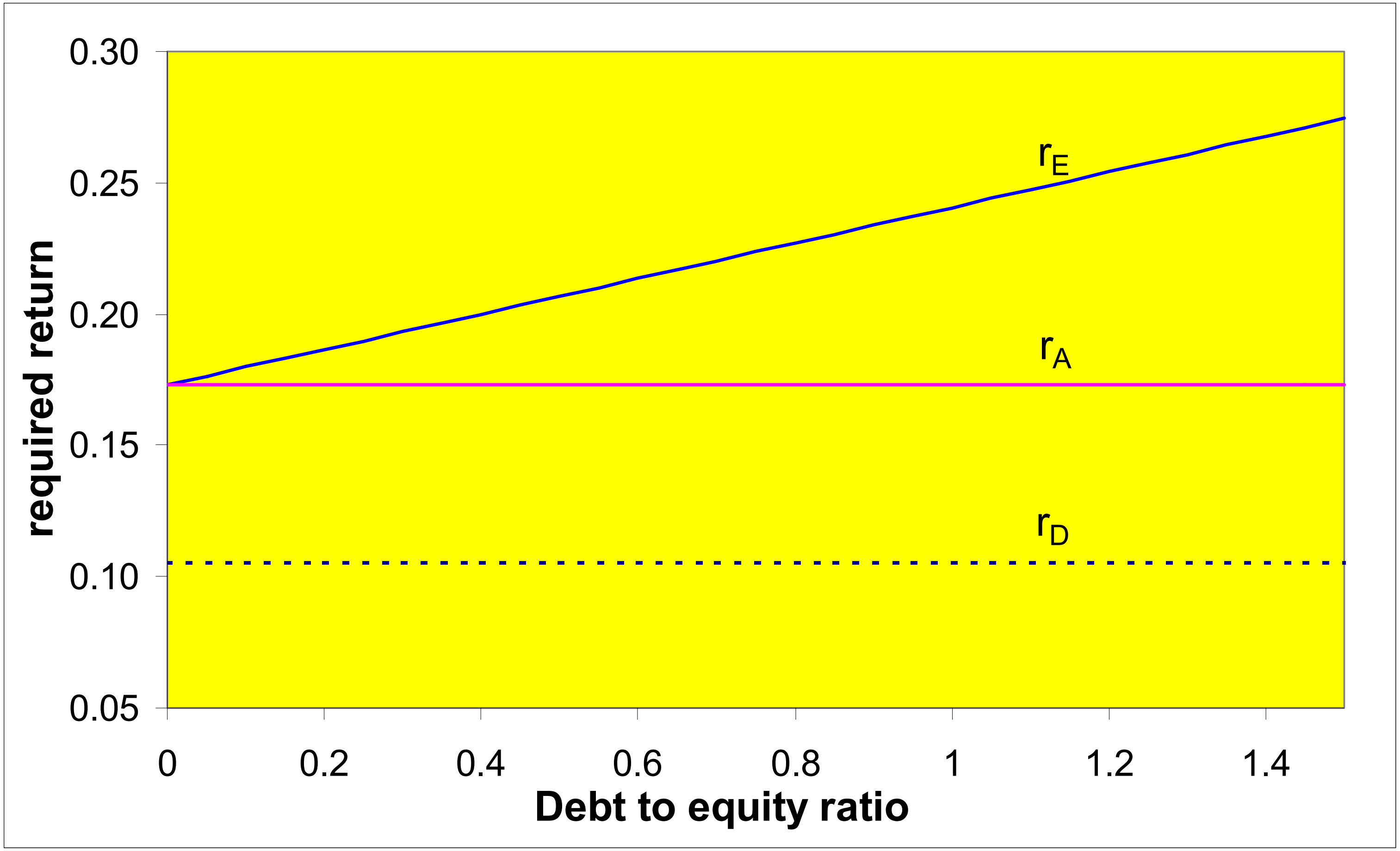
$$r_A = \frac{D}{V} r_D + \frac{E}{V} r_E$$

$$r_E = r_A + \frac{D}{E}(r_A - r_D)$$

Leverage and beta



Leverage and required returns



Business Risk and Financial Risk: Intuition

- Consider a project with β_A>0
- Its cash flows can be decomposed into:
  - Safe cash-flows
  - Risky cash-flows that are positively correlated with the market.
- As the level of debt increases (but remains relatively safe):
  - A larger part of the safe cash-flows goes to debtholders;
  - The residual left to equityholders is increasingly correlated with the market.

Note: If cash-flows were negatively correlated with the market (β_A<0), increasing debt would make equity more negatively correlated with the market and would reduce the required return on equity.

General Electric's WACC

- Assume $r_f = 6\%$
- We can get GE's $\beta_E = 1.10$ which implies

$$k_E = 6\% + 1.10 * 8\% = 14.8\%$$

- $k_D = 7.5\%$
- $D/(D+E) = .06$
- $t = 35\%$

$$\text{WACC} = .06 * 7.5\% * (1-35\%) + .094 * 14.8\% = 14.2\%$$

When Can GE Use This WACC in DCF?

- When the project under consideration has the same basic risk as the rest of the company (i.e., when the company is a good comp for its project).

- *And*, the project will be financed in the same way as the rest of the company.

    - For example, if GE is expanding the scale of entire operations then it should use its own WACC.

    - But, if planning to expand in only one of its many different businesses then it's not the right cost of capital.
        - In that case: Find publicly-traded comps and do unlevering / levering.

Important Warning

- Cost of capital is an attribute of an investment, *not* the company

- Few companies have a single WACC that they can use for all of their businesses.

GE's businesses:

- Financial services
- Power systems
- Aircraft engines
- Industrial
- Engineered plastics
- Technical products
- Appliances
- Broadcasting

How Firms Tend to Use WACC

They calculate their WACC using:

- Their current cost of debt k_D
- Their own current capital structure D/(D+E)
- Their own current cost of equity capital k_E (more on this soon).
- The marginal tax rate they are facing

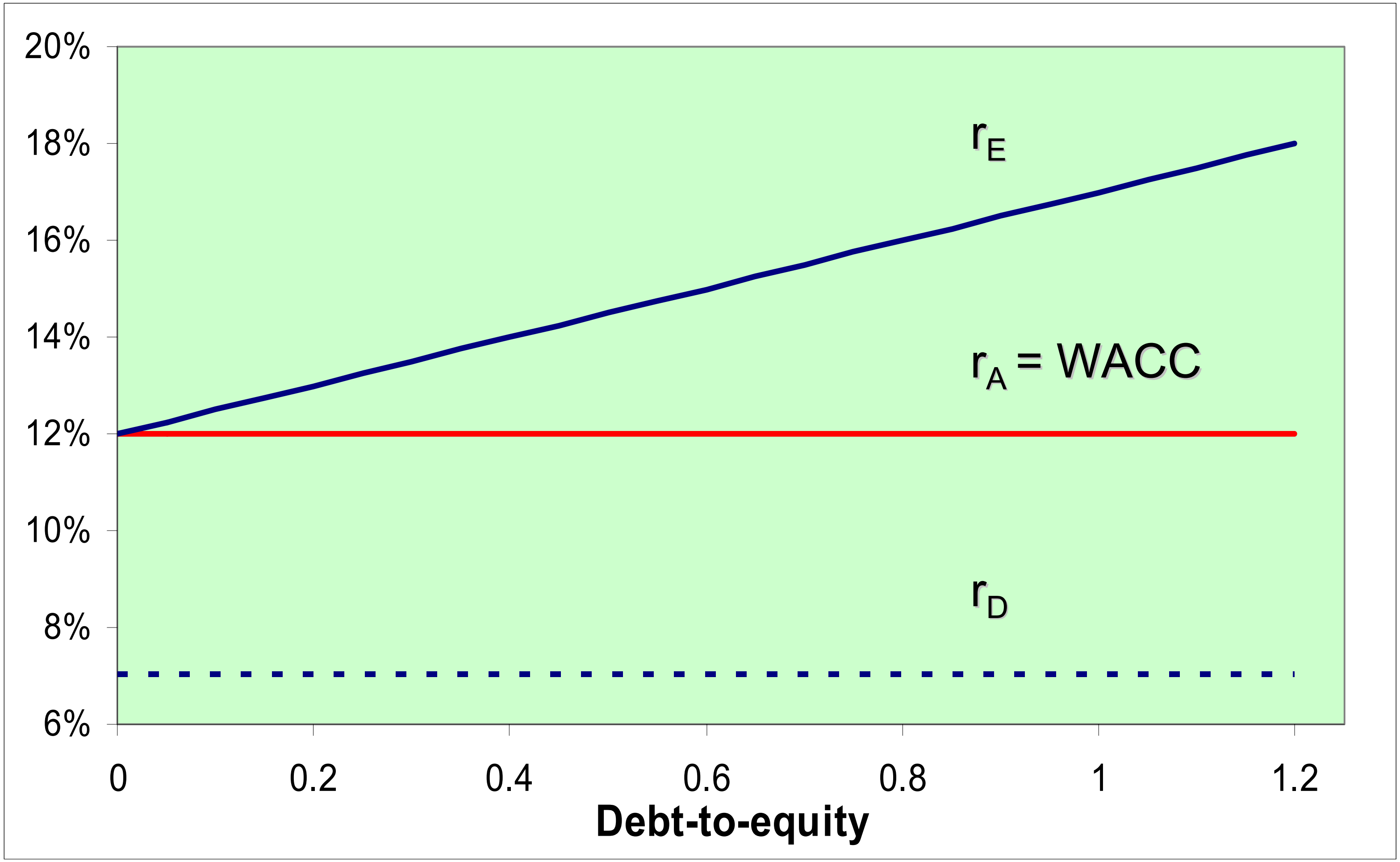
They discount all future FCF with:

- this (single) discount rate
- maybe adjusted for other things (e.g., project’s “strategic value”)

Selected Industry Capital Structures, Betas, and WACCs

Industry	Debt ratio (%)	Equity beta	Asset beta	WACC (%)
Electric and Gas	43.2	0.58	0.33	8.1%
Food production	22.90	0.85	0.66	11.0%
Paper and plastic	30.40	1.03	0.72	11.4%
Equipment	19.10	1.02	0.83	12.4%
Retailers	21.70	1.19	0.93	13.2%
Chemicals	17.30	1.34	1.11	14.7%
Computer software	3.50	1.33	1.28	16.2%
Average of all industries	21.50	1.04	0.82	12.3%
Assumptions: Risk-free rate 6%; market risk premium 8%; cost of debt 7.5%; tax rate 35%				

Relation to MM:
W/o taxes, WACC is independent of leverage



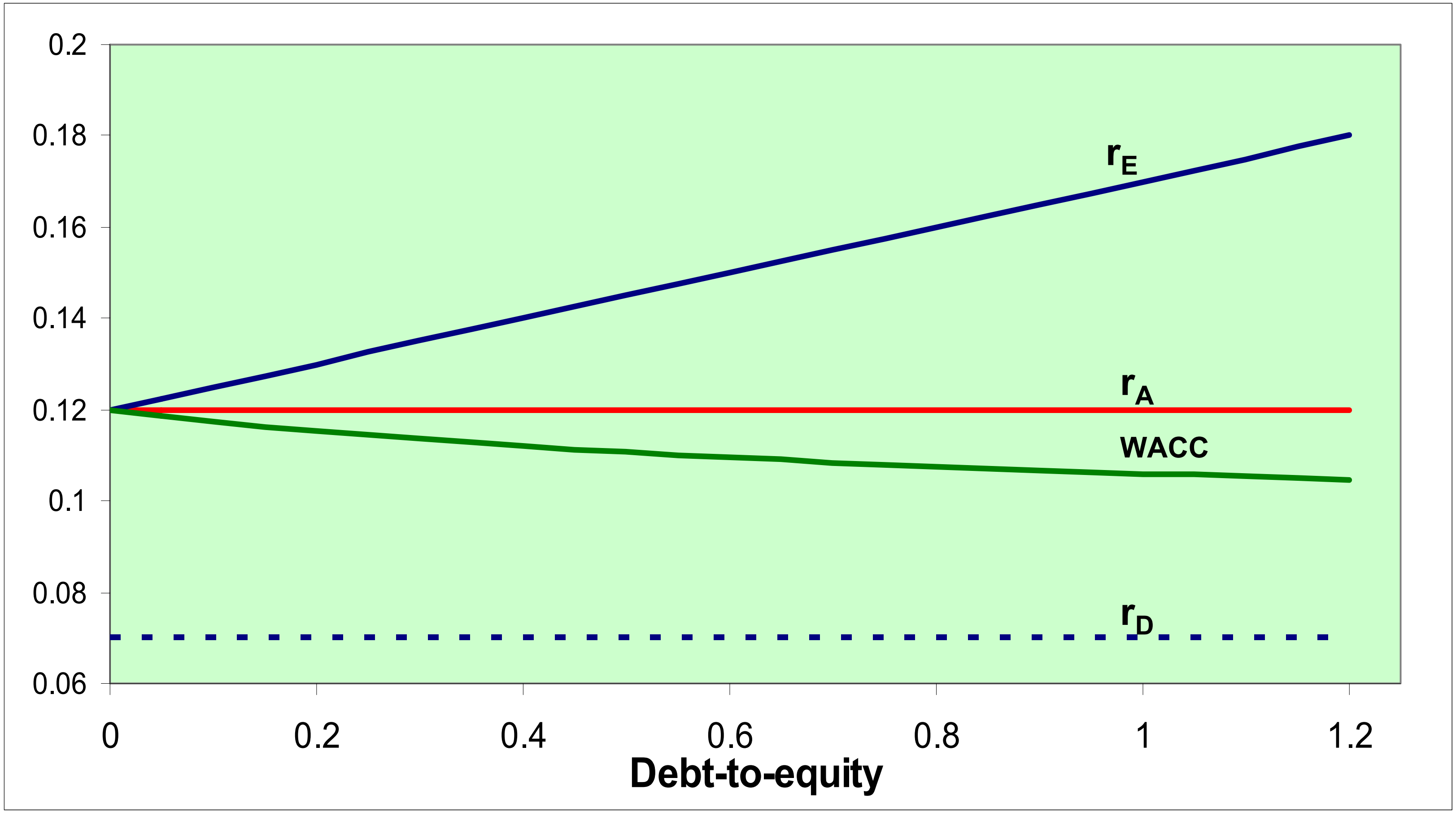
The WACC Fallacy (Revisited)

- The cost of debt is lower than the cost of equity (true).
- Does this mean that projects should be financed with debt?

$$\text{WACC} = k_D \frac{D}{D+E} + k_E \frac{E}{D+E}$$

- No: WACC is independent of leverage
- As you are tapping into cheap debt, you are increasing the cost of equity (its financial risk increases).

With taxes, WACC declines with leverage



2. APV

Adjusted Present Value

- Separates the effects of financial structure from the others.
- **Step 1:** Value the project/firm as if it were 100% equity financed.
- **Step 2:** Add the value of the tax shield of debt.

Note:

- This is simply applying MM-Theorem with taxes
- APV = Valuation by Components = ANPV

Step 1: Value if 100% Equity Financed

- Cash-flows: Free Cash Flows are exactly what you need.

- You need the rate that would be appropriate to discount the firm’s cash flows if the firm were 100% equity financed.

- This rate is the expected return on equity if the firm were 100% equity financed.

- To get it, you need to:
  - Find comps, i.e., publicly traded firms in same business.
  - Estimate their expected return on equity if they were 100% equity financed.

Step1: Value if 100% Equity Financed (cont.)

- Unlever each comp's β_E to estimate its asset beta (or all equity or unlevered beta) β_A using the appropriate unlevering formula

$$\boxed{\beta_A = \frac{E}{V}\beta_E + \frac{D}{V}\beta_D}$$

- Use the comps' β_A to estimate the project's β_A (e.g. average).

- Use the estimated β_A to calculate the all-equity cost of capital k_A

$$\mathbf{k_A = r_f + \beta_A * \text{Market Risk Premium}}$$

- Use k_A to discount the project's FCF

Example

- Johnson and Johnson operate in several lines of business: Pharmaceuticals, consumer products and medical devices.

- To estimate the all-equity cost of capital for the medical devices division, we need a comparable, i.e., a pure play in medical devices (we should really have several).

- Data for Boston Scientific:
  - Equity beta = 0.98
  - Debt = \$1.3b
  - Equity = \$9.1b.

Example (cont.)

- Compute Boston Scientific's asset beta:

$$\beta_A = \beta_E \frac{E}{E+D} = 0.98 \cdot \frac{9.1}{9.1+1.3} = 0.86$$

- Let this be our estimate of the asset beta for the medical devices business

- Use CAPM to calculate the all-equity cost of capital for that business (assuming 6% risk-free rate, 8% market risk premium):

$$k_A = 6\% + .86 * 8\% = 12.9\%$$

Step 2: Add PV(Tax Shield of Debt)

- Cash-flow: The expected tax saving is $tk_D D$ where k_D is the cost of debt capital (discussed earlier).

- If D is expected to remain stable, then discount $tk_D D$ using k_D

$$PVTS = tk_D D / k_D = tD$$

- If D/V is expected to remain stable, then discount $tk_D D$ using k_A

$$PVTS = tk_D D / k_A$$

- Intuition:
  - If D/V is constant, D ($tk_D D$) moves up/down with V
  - The risk of $tk_D D$ is similar to that of the firm's assets: use k_A

Step 2: Add PVTS (cont.)

- For many projects, neither D nor D/V is expected to be stable.

- For instance, LBO debt levels are expected to decline.

- In general you can estimate debt levels using:
  - repayment schedule if one is available,
  - financial forecasting

  and discount by a rate between k_D and k_A.

Extending the APV Method

- One good feature of the APV method is that it is easy to extend to take other effects of financing into account.

- For instance, one can value an interest rate subsidy separately as the PV of interest savings.

APV= NPV(all-equity) + PV(Tax Shield) + PV(other stuff)

WACC vs. APV

Pros of WACC: Most widely used

- Less computations needed (before computers).
- More literal, easier to understand and explain (?)

Cons of WACC:

- Mixes up effects of assets and liabilities. Errors/approximations in effect of liabilities contaminate the whole valuation.
- Not very flexible: What if debt is risky? Cost of hybrid securities (e.g., convertibles)? Other effects of financing (e.g., costs of distress)? Non-constant debt ratios?

Note: For non-constant debt ratios, could use different WACC for each year (see appendix) but this is heavy and defeats the purpose.

WACC vs. APV (cont.)

Advantages of APV:

- No contamination.
- Clearer: Easier to track down where value comes from.
- More flexible: Just add other effects as separate terms.

Cons of APV:

- Almost nobody uses it.

Overall:

- For complex, changing or highly leveraged capital structure (e.g., LBO), APV is much better.
- Otherwise, it doesn't matter much which method you use.

Appendix

Appendix A: Unlevering Formula for a Constant Debt Ratio D/V

- Consider a firm with perpetual expected cash-flows, X.
- Capital structure: Debt worth D and equity worth E

$$E + D = V_{\text{all-equity}} + PVTS$$

- By definition, the all-equity cost of capital is the rate k_A that is appropriate for discounting the project's FCF, (1-t)X.

- Moreover, since the firm's D/V is stable, PVTS= tDk_D / k_A

$$E + D = \frac{(1-t)X}{k_A} + \frac{t\,k_D\,D}{k_A} \qquad \text{or} \qquad k_A = \frac{(1-t)X + t\,k_D\,D}{E + D}$$

Appendix A: Unlevering Formula for a Constant Debt Ratio D/V (cont.)

- Debt- and equity-holders share each year’s (expected) cash-flows

$$\overbrace{(1-t)X}^{\substack{\text{Expected after-tax cashflow}\\ \text{if 100\% equity financed}}} + \overbrace{tk_D D}^{\substack{\text{Annual tax shield}\\ \text{of debt}}} = \overbrace{k_D D}^{\substack{\text{Expected}\\ \text{payment to debt}}} + \overbrace{k_E E}^{\substack{\text{Expected}\\ \text{payment to equity}}}$$

- Eliminating X, we get:

$$k_A = k_D \frac{D}{E+D} + k_E \frac{E}{E+D}$$

- Translating into betas (all relationships being linear) yields:

$$\beta_A = \beta_D \frac{D}{E+D} + \beta_E \frac{E}{E+D}$$

$$\text{and so if } \beta_D \approx 0 \text{ we have } \beta_A = \beta_E \frac{E}{E+D}$$

Appendix B: Unlevering Formula for a Constant Debt Level D

- Consider a firm with perpetual expected cash-flows, X.
- Capital structure: Debt worth D and equity worth E

$$E + D = V_{\text{all-equity}} + PVTS$$

- Since the firm's D is constant over time, PVTS= tD

$$E + D = \frac{(1-t)X}{k_A} + tD \qquad \text{or} \qquad k_A = \frac{(1-t)X}{E + D(1-t)}$$

Appendix B: Unlevering Formula for a Constant Debt Level D (cont.)

- Debt- and equity-holders share each year's (expected) cash-flows

$$\overbrace{(1-t)X}^{\text{Expected after-tax cashflow if 100\% equity financed}} + \overbrace{tk_D D}^{\text{Annual tax shield of debt}} = \overbrace{k_D D}^{\text{Expected payment to debt}} + \overbrace{k_E E}^{\text{Expected payment to equity}}$$

- Dividing both sides by (D+E), we get (see formula for k_A above):

$$k_A = k_D \frac{D(1-t)}{E+D(1-t)} + k_E \frac{E}{E+D(1-t)}$$

- Translating into betas yields:

$$\beta_A = \beta_D \frac{D(1-t)}{E+D(1-t)} + \beta_E \frac{E}{E+D(1-t)}$$

$$\text{and so if } \beta_D \approx 0 \text{ we have } \beta_A = \beta_E \frac{E}{E+D(1-t)}$$

Appendix C: WACC vs. APV: Example

Objective of the example:

- See APV and WACC in action.
- Show that, when correctly implemented, APV and WACC give identical results.
- Correctly implementing WACC in an environment of changing leverage.
- Convince you that APV is the way to go.

WACC vs. APV: Example (cont.)

Anttoz Inc., a Fortune 500 widget company, is planning to set up a new factory in New Orleans with cash flows as presented on the next slide:

- The new plant will require an initial investment in PPE of $75 million, plus an infusion of $10 million of working capital (equal to 8% of first-year sales).
- Sales are projected to be $125 million in the first year of operation. Sales are projected to rise a whopping 10% over the next two years, with growth stabilizing at a 5% rate indefinitely thereafter.
- Anttoz's army of financial analysts estimate that cash costs (COGS, GS&A expenses, etc.) will constitute 50% of revenues.
- New investment in PPE will match depreciation each year, starting at 10% of the initial $75 million investment and growing in tandem with sales thereafter.
- The firm plans to maintain working capital at 8% of the following year's projected sales.

WACC vs. APV: Example (cont.)

- With Anttoz Widgets Inc. in the 35% tax bracket, FCF would approach $45 million in three years, and grow 5% per year thereafter.
- The required rate of return on the project's assets, k_A, is 20%.
- The project supports a bank loan of $80 million initially with $5 million principal repayments at the end of the first three years of operation, bringing debt outstanding at the end of the third year to $65 million.
- From that point on, the project's debt capacity will increase by 5% per year, in line with the expected growth of operating cash flows. Because of the firm's highly leveraged position in the early years, the borrowing rate is 10% initially, falling to 8% once it achieves a stable capital structure (after year 3).

WACC vs. APV: Example (cont.)

	Year 0	Year 1	Year 2	Year 3	Year 4
Sales		125,000	137,500	151,250	158,813
Cash Costs		62,500	68,750	75,625	79,406
Depreciation		7,500	8,250	9,075	9,529
EBIT		55,000	60,500	66,550	69,878
Corporate Tax		19,250	21,175	23,293	24,457
Earnings Before Interest After Taxes		35,750	39,325	43,258	45,420
+ Depreciation		7,500	8,250	9,075	9,529
Gross Cash Flow		43,250	47,575	52,333	54,949
Investments into					
Fixed Assets	75,000	7,500	8,250	9,075	9,529
Net Working Capital	10,000	1,000	1,100	605	635
Unlevered Free Cash Flow	**(85,000)**	**34,750**	**38,225**	**42,653**	**44,785**
Debt Level	**80,000**	**75,000**	**70,000**	**65,000**	**68,250**

WACC vs. APV: Example (cont.)

	Year 0	Year 1	Year 2	Year 3	Year 4
APV					
Unlevered FCF	(85,000)	34,750	38,225	42,653	44,785
Unlevered Value	252,969	268,813	284,350	298,568	313,496
Interest Tax Shield		2,800	2,625	2,450	1,820
Discounted Value of TS	52,135	54,549	57,379	60,667	63,700
Levered Value	**305,104**	**323,361**	**341,729**	**359,234**	**377,196**

WACC vs. APV: Example (cont.)

	Year 0	Year 1	Year 2	Year 3	Year 4
APV					
Unlevered Value	252,969	268,813	284,350	298,568	313,496
Discounted Value of Tax Shields	52,135	54,549	57,379	60,667	63,700
Levered Value	**305,104**	**323,361**	**341,729**	**359,234**	**377,196**
WACC					
Value of Debt	80,000	75,000	70,000	65,000	68,250
Value of Equity	225,104	248,361	271,729	294,234	308,946
Required Equity Return	21.2%	20.8%	20.5%	20.2%	20.2%
WACC	17.4%	17.5%	17.6%	17.5%	17.5%
WACC Discounted FCF	**305,104**	**323,361**	**341,729**	**359,234**	**377,196**