THE COST OF CAPITAL AND ASSET BETAS

Risk, Asset Pricing, and Discount Rates

- We need a rate *r* to discount cash flows for a project -- the project's "cost of capital"
- Recall: $r = r_f$ + risk premium
- For what types of risk do investors get a risk premium?
  - *Systematic* – e.g. risk that's correlated with the stock market
    - or, other priced "risk factors"
- This holds for securities, but applies equally (by the *opportunity cost* principle) when seeking the correct discount rate *r* for projects
- Today: How to get the right "cost of capital" for a project!
  - But to do that, we first need to get costs of capital for equity and debt

EQUITY AND DEBT COST OF CAPITAL

Estimating a firm's equity cost of capital

$$E[R_i] = r_f + \beta_{i,mkt} * \left(E[R_{mkt}] - r_f\right)$$

- We usually think of this equation from an investor's perspective:
  - The expected return an investor should get for investing in a stock
- But, any money investors are expected to get must be exactly equal to the money the firm is expected to pay out!
  - (Not necessarily true that money earned is money paid for any one individual investor because of trading, but we know it must be true for the firm's investors as a group!)
  - So from the firm's perspective, this is its "*equity cost of capital*" (sometimes called "*cost of equity*")
- Example:
  - Suppose the equity beta of DuPont is 1.37, the yield on long-term treasuries is 3%, and you estimate the market risk premium to be 6%
  - According to CAPM, what's the expected return for an investor who invests in DuPont's stock?
  - What's DuPont's cost of equity?

Example: Betas with Respect to the S&P 500 for Individual Stocks

(calculated based on monthly data for 2004–2008)

What types of firms tend to have high vs. low equity betas?

Company	Ticker	Industry	Equity Beta
Family Dollar Stores	FDO	Retail	0.10
Abbott Laboratories	ABT	Pharmaceuticals	0.18
Consolidated Edison	ED	Utilities	0.19
Hershey	HSY	Food Processing	0.19
Piedmont Natural Gas	PNY	Gas Utilities	0.24
General Mills	GIS	Food Processing	0.25
Wal-Mart Stores	WMT	Superstore	0.31
Altria Group	MO	Tobacco	0.31
Kellogg	K	Food Processing	0.44
Amgen	AMGN	Biotechnology	0.45
DeVry	DV	Education Services	0.49
Exxon Mobil	XOM	Oil and Gas	0.56
Procter & Gamble	PG	Household Products	0.57
The Coca-Cola Company	KO	Soft Drinks	0.60
Newmont Mining	NEM	Gold	0.65
McDonald's	MCD	Restaurants	0.79
United Parcel Service	UPS	Air Freight and Logistics	0.79
Southwest Airlines	LUV	Airline	0.83
Costco Wholesale	COST	Superstore	0.85
Walt Disney	DIS	Movies and Entertainment	0.96
Microsoft	MSFT	Systems Software	0.98
Starbucks	SBUX	Restaurants	1.04
Target	TGT	Retail	1.07
General Electric	GE	Conglomerates	1.12
Cisco Systems	CSCO	Communications Equipment	1.27
Marriott International	MAR	Hotels and Resorts	1.29
Intel	INTC	Semiconductors	1.35
Dell	DELL	Computer Hardware	1.36
Sears	SHLD	Department Stores	1.36
Google	GOOG	Internet Services	1.45
Tiffany & Co.	TIF	Specialty Stores	1.64
Coach	COH	Apparel and Luxury Goods	1.65
Apple	AAPL	Computer Hardware	1.89
Amazon.com	AMZN	Internet Retail	1.89
eBay	EBAY	Internet Services	1.93
Sotheby's	BID	Auction Services	2.07
Autodesk	ADSK	Application Software	2.31
Salesforce.com	CRM	Application Software	2.39

Source: CapitalIQ

Estimating a firm's debt cost of capital

- Recall: the "equity cost of capital" (r_e) is the expected return for an equity investor
- Similarly, the "debt cost of capital" (r_d) is the expected return for a debt investor!
  - This is not exactly true if debt is deductible for corporate tax purposes, in which case the *after-tax cost* to the firm for debt payments is less than what the investor receives, but let's assume no corporate taxes for a moment…
- Two ways to estimate (r_d):

1. Adjust the debt's promised yield for the risk of default
   - Why adjustment required? Because expected returns are always lower than promised yields!

   OR

2. Estimate a debt beta and apply CAPM
   - CAPM (in theory) applies to all tradeable financial assets, including equities, debt, preferred, gold, REITs, etc…

Method 1: Adjust promised yields for the risk of default

- If there is significant risk of default, yield (*y*) will overstate investors' expected return (r_d)

Example:

- Consider a one-year zero-coupon bond with yield of *y*.
- For each $1 invested in the bond today, the issuer promises to pay $(1+y) in one year.
- Suppose the bond will default with probability p, in which case bond holders receive only $(1+y-L), where L is the expected loss per $1 of debt in the event of default.
- So the expected return (r_d) of the bond is:
  $r_d = (1-p)y + p(y-L) = y - pL$
  = Yield – Prob(default) X Expected Loss (%)
- But how estimate Prob(default) and Expected Loss?

Note: This formula is really only applies in this example (one year zero-coupon). It might sometimes also be a reasonable approximation in other settings, but we will discuss an exact method in "bond valuation" lecture

Method 1: Adjust promised yields for the risk of default (cont.)

- We can use the **bond's rating** to **estimate the probability of default:**

Table: Annual Default Rates by Debt Rating (1983–2008)

Rating:	AAA	AA	A	BBB	BB	B	CCC	CC-C
Default Rate:								
Average	0.0%	0.0%	0.2%	0.4%	2.1%	5.2%	9.9%	12.9%

Example:

- Annual default rates for B-rated bonds is 5.2% (from Table)
- The average loss rate for unsecured debt (most bonds are unsecured) is 60%, although this can vary across industries
- So the *expected return* to B-rated bondholders during average times is 0.052X0.60=3.1% *below* the bond's promised yield

Method 2. Estimate a debt beta and apply CAPM

- Alternatively, we can estimate the debt cost of capital using the CAPM:

$$E[R_i] = r_f + \beta_{i,mkt} * \left(E[R_{mkt}] - r_f\right)$$

- BUT, debt betas are *difficult to estimate* because corporate bonds are *traded infrequently!*
  - So weekly or monthly prices and returns might be "stale"
  - Bonus question: What happens to estimates of betas if prices are stale due to no trading?
- One approximation is to use estimates of debt betas by *rating* (lower rated bonds tend on average to have higher systematic risk):

Rating Category	A and above	BBB	BB	B	CCC
Avg. Beta	<0.05	0.10	0.17	0.26	0.31

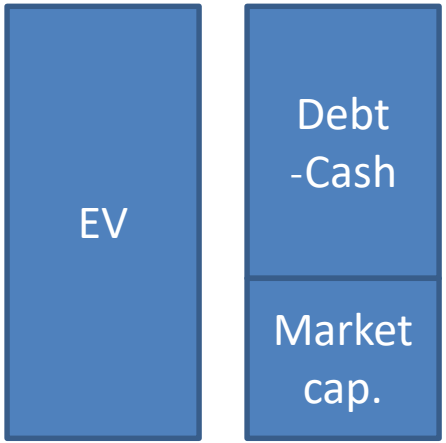
Source: Schaefer and Strebulaev (2009)

A PROJECT'S COST OF CAPITAL

A **Project's** Cost of capital / Asset Beta

- We now know how to get a firm's cost of equity (r_e), equity beta (β_e), cost of debt (r_d), and debt beta (β_d)
- To evaluate an investment in a project (a new product, machine, plant, technology, or in a firm that produces cash flows), we need a cost of capital and beta for the *project*
  - **"Asset beta" ($\boldsymbol{\beta_a}$) and "Asset cost of capital" ($\boldsymbol{r_a}$)**!
  - Idea behind the beta is the same: captures the sensitivity of the **project** to systematic risk factor(s) (e.g., correlation to stock market)
- How can we find an appropriate asset beta for a project?
- One way, is to find a **traded firm** whose projects have a similar risk profile as our project and use that firm's asset beta and asset cost of capital (this is called the "Twin Method")
  - By the opportunity cost principle, our project, if it's equally risky, should have the same expected return as the twin firm!
  - Issue: We don't directly observe the twin firm's asset beta!
  - Solution: we can calculate the asset beta from that firm's equity and debt betas!

Recall that :
EV = Net Debt + Market cap



A firm's enterprise value corresponds directly to a *portfolio* consisting of the firm's net debt and equity, so:

$$E[R_{EV}] = w_d * E[R_d] + w_e * [R_e]$$

where w_d and w_e are the market-value weights of debt/equity

The same relation holds for betas!

$$\beta_{EV} = w_d * \beta_d + w_e * \beta_e$$

And what makes up a firm's enterprise value? The sum of its projects! So we can equivalently write:

$$\beta_{EV} = \overline{\beta_a} = w_d * \beta_d + w_e * \beta_e$$

where the firm's asset beta, β_a, is the average (value-weighted) project beta across all the firm's projects!

The "Twin Method" in five steps

1. Identify a comparable publicly-traded "twin" firm
   - Firm with activities that have same (average) risk profile as the project you want to evaluate
   - If the project is "average" for your your firmnd your firm is publicly traded, the best "twin" might be yourself!
2. Find (or calculate) the twin firm's equity beta
3. "Guess" (or if you can, calculate) the twin's debt beta
   - A good guess is good enough; it's usually not a big deal if your estimate is slightly off…
4. Calculate the twin's asset beta as the weighted average:

$$\beta_a = w_d * \beta_d + w_e * \beta_e$$

5. Plug the asset beta into CAPM to determine the *cost of capital* for your project*:*

$$r_a = r_f + \beta_a * \left(E[R_{mkt}] - r_f\right)$$

Note: the project/asset cost of capital, r_a, is also sometimes called the "unlevered cost of capital", r_u, because it's the correct cost of capital for a 100% equity-financed (*i.e.*, unlevered) project.
But what if a project is not 100%-equity financed? We will deal with that shortly!

Example: Asset beta and cost of capital

- US Metal Reserves has an equity beta of 1.25, and a debt beta of 0.1
- The firm is financed with 70% equity and 30% debt
- The risk-free rate is 2%, and the market premium 6%
- What is the asset beta and cost of capital for a project that has similar risk as US Metal Reserves' overall business?

Solution

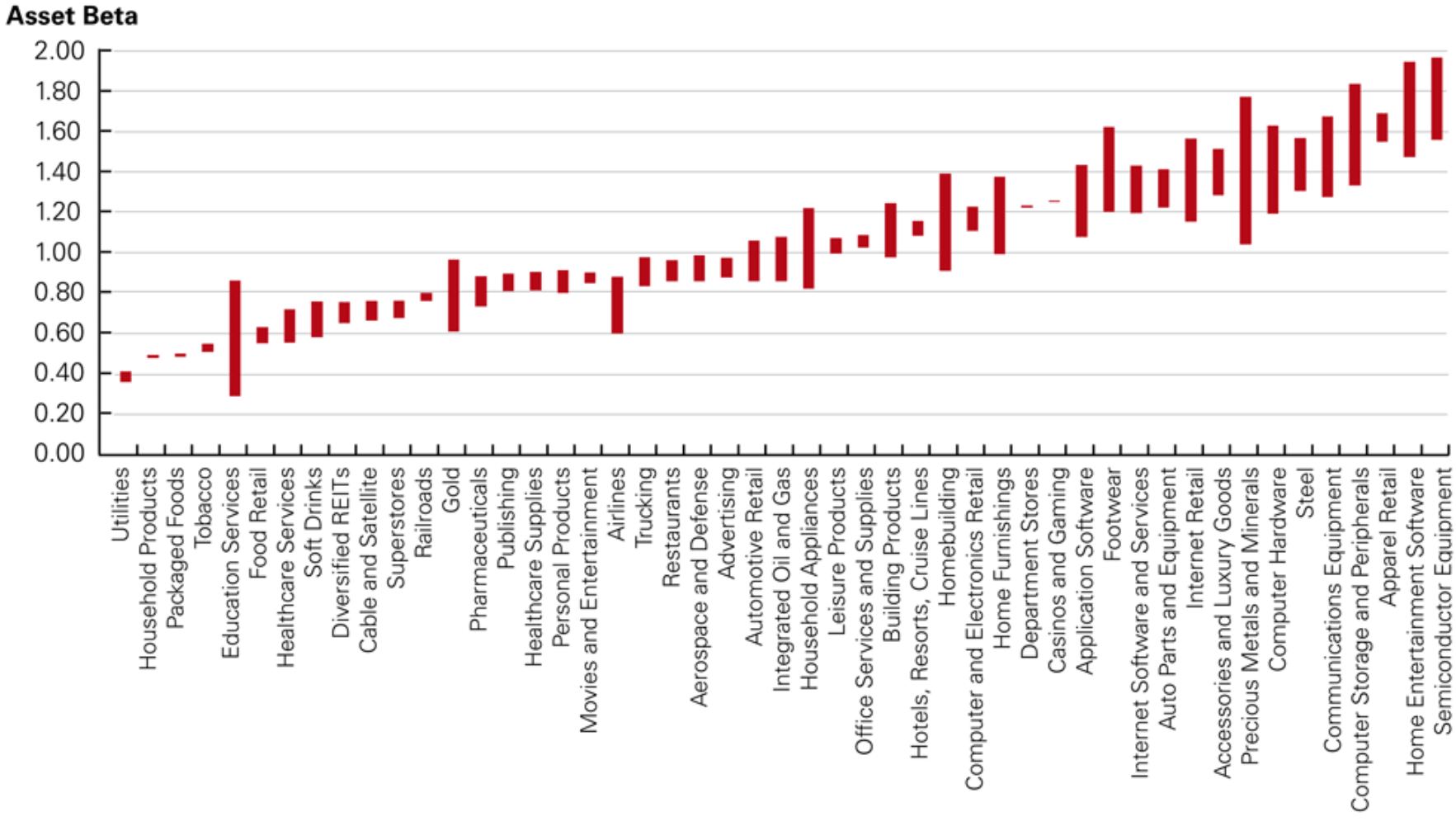
- US Metal Reserves' asset beta (unlevered beta) is:

$$\beta_a = 70\% * 1.25 + 30\% * 0.1 = 0.905$$

  notice: the asset beta is lower than the equity beta; this is generally true as long as leverage is positive!

- The cost of capital for a project with similar risk is then:

$$r_a = r_f + \beta_a * (E[R_m] - r_f) = 2\% + 0.905 * (6\%) = 7.43\%$$


Asset Beta
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Utilities
Household Products
Packaged Foods
Tobacco
Education Services
Food Retail
Healthcare Services
Soft Drinks
Diversified REITs
Cable and Satellite
Superstores
Railroads
Gold
Pharmaceuticals
Publishing
Healthcare Supplies
Personal Products
Movies and Entertainment
Airlines
Trucking
Restaurants
Aerospace and Defense
Advertising
Automotive Retail
Integrated Oil and Gas
Household Appliances
Leisure Products
Office Services and Supplies
Building Products
Hotels, Resorts, Cruise Lines
Homebuilding
Computer and Electronics Retail
Home Furnishings
Department Stores
Casinos and Gaming
Application Software
Footwear
Internet Software and Services
Auto Parts and Equipment
Internet Retail
Accessories and Luxury Goods
Precious Metals and Minerals
Computer Hardware
Steel
Communications Equipment
Computer Storage and Peripherals
Apparel Retail
Home Entertainment Software
Semiconductor Equipment

Why can't we simply use the twin's β_e instead of calculating β_a?

- Recall:

$$\beta_a = \frac{D}{D+E} * \beta_d + \frac{E}{D+E} * \beta_e$$

- Solving this for β_e, we can show that:

$$\beta_e = \beta_a + \frac{D}{E}(\beta_a - \beta_d)$$

"equity risk" = "business risk" + "added risk because of leverage"

This reflects the fact that a firm's equity mechanically gets riskier the more leverage the firm has

- Our goal is to isolate the project's risk, which is what we should use to evaluate the project
- β_a isolates the twin's business risk, which reflects the risk of the twin's projects, where as β_e **mixes** this business risk with the added risk from leverage

How do we get the Debt Beta?

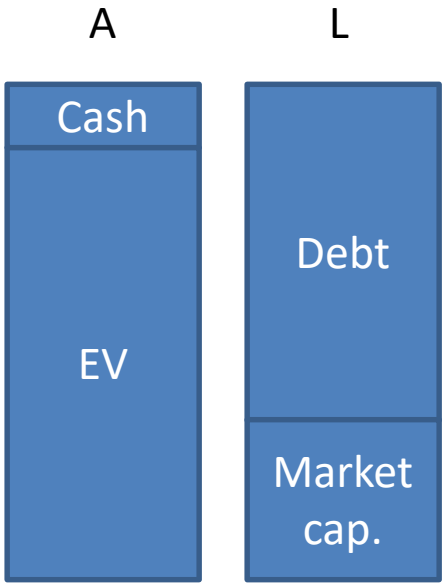
- If the twin only has very little debt (*i.e.*, $\frac{D}{D+E}$ is low) and the debt therefore is "safe," then okay to assume the debt beta is zero
- If the debt is more risky, then we can use an estimated beta for debt of that particular rating:

Rating Category	A and above	BBB	BB	B	CCC
Avg. Beta	<0.05	0.10	0.17	0.26	0.31

Source: Schaefer and Strebulaev (2009)

We use net debt for these calculations

- Recall: Net Debt = Debt – Excess Cash
  - Where we can define "Cash" broadly as any asset held for investment purposes (including CDs, bonds, treasuries, etc…), and that is not part of the firm's operational business
  - Recall that it's sometimes not obvious to define how much is "excess"…
- Suppose we used Debt + Equity on the financing side (see figure on right), then we would have cash+business(EV) on the left
  - The value-weighted beta of equity and debt (on the right) is now equal to the value-weighted beta of a portfolio of cash and the business (on the left)
  - But "cash" is a very low-beta asset (e.g. in the case of a checking account, the beta is exactly zero---a dollar in the bank is worth exactly a dollar regardless of if the stock market goes up or down!)
    - Much lower beta than the firm's business
  - So the value-weighted beta of equity and debt is too low if what we care about is the beta of the firm's projects/business!
- By using net debt we implicitly assume that the beta of excess cash is equal to the beta of debt, which is usually okay; but may not be reasonable if the firm's β_d is very high (e.g., if the firm has very high leverage)



Example: Finding the right β_a

- Telecommunications conglomerate AT&Bell's (ATB) principal business consists of offering "land-line" telephone services throughout the country
- ATB is considering entering a new market for cell phone services
  - It would finance this project with 100% equity
- ATB is publicly traded, with E=$1 billion, D=$0.5 billion, β_e=0.7, β_d=0.05
- The risk-free rate is 5% and the market premium is 6%

- What's ATB's asset beta? Can it use this asset beta to evaluate the new business opportunity?
- What cost of capital is appropriate for evaluating this project?

Solution

- No, ATB cannot use its own discount rate and asset beta to evaluate this project!
  - Why?
- Let's say another firm, Verisprint, is in the cell phone service business
- The market value of Verisprint's equity is E = $1.2B, with a beta of 1.5
- The value of Verisprint's debt is D = $0.4B, with a beta of 0.4
- Let's solve it!

What makes a good comparable twin?

- To get the asset beta, the most important characteristic for a good "twin" is having similar business operations, and more precisely, similar systematic risk exposure
- We don't necessarily need to match on firm size, leverage/capital structure, etc…

How many twins to use?

- Trade-off between accuracy and precision! (We often can't get an estimate that's both accurate and precise)
- Using only one twin (the best match in terms of business operations and risk) may give us the most accurate estimate of β_a on average, but this estimate may be noisy (low precision)
- Using more comparable firms sacrifices a bit of accuracy but gives us better precision by canceling some idiosyncratic noise in our estimates
- Not necessary to give all twins the same weight if we take an average, if we believe that some are more accurate than others

Each project should have its own asset beta!

- Whenever possible, a firm should use a *different cost of capital for each project,* corresponding to the risk profile of that specific project
  - The firm's own asset beta reflects the systematic risk of the (value-weighted) *average project* in a firm
  - But individual divisions or projects in the firm may have a risk that's lower or higher than this average
  - ➢ We should evaluate less-risky projects with a lower-than-average discount rate, and vice versa!
- When can a firm use its *own* asset beta to evaluate a project?
  - Only when the project's characteristics are identical to the *average risk of the rest of the firm*
  - For all other projects, it's best to use a "pure play" beta, *i.e.* an asset beta that comes from a "twin" firm that's only active in the new project's business
  - But, if no such firm is available, sometimes the best we can do is to use the firm's own asset beta…

When to use twin's asset beta vs. own asset beta

Twin's Asset Beta

- your firm is evaluating a project in twin's business

Own Asset Beta

Can only use if your firm is publicly traded

- Evaluating a project that's "average" for your firm, particularly if it involves a different capital structure

Twin's Equity and Debt Beta

- your firm is evaluating a project in twin's business and twin has similar capital structure

Own Equity and Debt Beta

Can only use if your firm is publicly traded

- Evaluating a project that's "average" for your firm and financed with similar capital structure

Important fallacy: What will happen if a firm uses the same discount rate for all projects?

- This will lead the firm to erroneously accept some negative NPV projects and reject some positive NPV projects!
- Pick the correct option:
  - The firm will *overstate* NPV for projects that are:
    - (a) risky, or
    - (b) safe?
  - The firm will *understate* NPV for projects that are:
    - (a) risky, or
    - (b) safe?
  - These decisions will make the *average risk* of the firm to:
    - (a) increase, or
    - (b) decrease?

What if the firm uses leverage to finance the project?

- Recall: r_a is the correct discount rate when considering an 100%-*equity financed* project
- Is the project's cost of capital different if we use some debt to finance it?
- "Perfect capital markets"
  - Given a set of simple assumptions called "perfect capital markets" (these assumptions include no trading costs, no issuance costs, no taxes, every security is fairly priced), the choice of financing (debt vs. equity) does not affect the cost of capital!
  - This is the famous *Modigliani-Miller theorem*; we'll discuss this a lot more later in the course!
- But, Taxes – A Big Imperfection!
  - When interest payments on debt are tax deductible, the **net cost to the firm** from using debt is different from the return the investors in that debt expect to get:

After-tax cost of debt = $r_d(1 - taxrate_c)$

The Weighted Average Cost of Capital

Weighted Average Cost of Capital (WACC):

$$r_{wacc} = \frac{E}{E+D} r_e + \frac{D}{E+D} r_d (1 - taxrate_c)$$

We can substitute in $r_a = \frac{E}{E+D} r_e + \frac{D}{E+D} r_d$ in this equation to get:

$$r_{wacc} = r_a - \frac{D}{E+D} r_d * taxrate_c$$

Notice: If D>0 and corporate taxes are positive, WACC is *lower* than r_a, as WACC reflects the tax benefit of debt financing

Estimating the WACC

Problem

Dunlap Corp. has a market capitalization of $100 million, and $25 million in outstanding debt. Dunlap's equity cost of capital is 10%, and its debt cost of capital is 6%. What is Dunlap's unlevered cost of capital? If its corporate tax rate is 40%, what is Dunlap's weighted average cost of capital?

Takeaways

- Two ingredients to getting NPV right
  - Cash Flows
  - Discount Rates
- The right discount rate for a *project* depends on its beta, β_a
  - If a firm is has several projects that each have different risk profiles, the firm should use different β_a for each project!
- Getting the project's cost of capital:
  - Estimate an asset beta β_a, by using twin method
  - Plug this β_a into CAPM to get: $E[R_a] = r_f + \beta_a * (E[R_{mkt}] - r_f)$
  - $E[R_a]$ is the correct cost of capital for the project if it is 100% equity financed
- If project is not 100% equity financed, we can calculate WACC
  - WACC depends on $E[R_a]$, but additionally accounts for the tax advantage of using debt financing