

## 15.414: COURSE REVIEW

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MAIN IDEAS OF THE COURSE.

- **Valuation:**
- **Approach:** Discounted Cashflows (i.e. PV, NPV):

$$PV = \frac{CF_1}{(1+r_1)} + \frac{CF_2}{(1+r_2)^2} + \dots$$

and

$$NPV = CF_0 + \frac{CF_1}{(1+r_1)} + \frac{CF_2}{(1+r_2)^2} + \dots$$

Explanation and motivations for this concept are found in BM Chapter 2.

- **Requirements:** What are the cashflows? What discount rates to use?
- **Cashflows:** Need to know how to go from accounting forecasts to cashflow forecasts. Requires following adjustments:

$$CF = EBT D \times (1 - tax) + DEP \times tax + CAPX - \Delta NWC$$

or

$$CF = NI + DEP + CAPX - \Delta NWC.$$

These two formulas give the same answer. Note that CAPX is entered as a negative entry (i.e. \$1M in capital expenditures would imply CAPX = -1M). See Recitation II for explanations.

- **Discount Rates:** Discussion on this later. Based on CAPM's notion of risk and the risk premium.
- **Applications:** PV of bonds, perpetuities, annuities, stocks. NPV of projects.
- **Bonds:** A bond promises to make cashflow payments according to the following rule: pays a face value  $F$  in  $T$  years and a semi-annual coupon  $C$ :

$$(0.1) \quad PV = \frac{C}{(1+r)} + \dots + \frac{C}{(1+r)^{2T}} + \frac{F}{(1+r)^{2T}}.$$

Note that  $r$  in this case is the effective 6 month discount rate.

- **Perpetuities:** Promises to make a payment  $M$  every year forever:

$$(0.2) \quad PV = \frac{M}{(1+r)} + \frac{M}{(1+r)^2} + \dots = \frac{M}{r}$$

where  $r$  is the effective 1 year discount rate now. We'll use this convention for  $r$  unless otherwise noted throughout these notes.

- **Growing Perpetuities:** Promises to make a payment of  $M$  next year and payments growing at a rate  $g < r$  every year forever afterwards:

$$(0.3) \quad PV = \frac{M}{(1+r)} + \frac{M(1+g)}{(1+r)^2} + \dots = \frac{M}{r-g}.$$

- **Annuities:** Promises to make a payment  $M$  every year for  $T$  years:

$$(0.4) \quad PV = \frac{M}{(1+r)} + \dots + \frac{M}{(1+r)^T} = \frac{M}{r} - \frac{M}{(1+r)^T r}.$$

- **Stocks:** Need forecasts of quarterly dividend payments  $D_1, D_2, \dots$ :

$$(0.5) \quad PV = \frac{D_1}{(1+r)} + \frac{D_2}{(1+r)^2} + \dots$$

where  $r$  is the effective quarterly discount rate. If the forecasts are that dividends will stay constant forever at  $D$ , we just use the perpetuity formula. If the forecasts are that the dividends will grow every year, we use the growing perpetuity formula.

- **Estimating Dividend Growth:** Two ways to get an estimate of dividend growth: 1) Directly from the price...

$$(0.6) \quad P = \frac{D}{r-g} \quad \Rightarrow \quad g = r - \frac{D}{P}.$$

2) From firm's reinvestment (plowback) policy...

$$(0.7) \quad g = ROE \times \text{plowback}$$

The intuition for this last estimate is that growth should be higher when the firm is more profitable (i.e. higher ROE) or when the firm reinvests more (i.e. higher plowback ratio). Remember plowback ratio equals 1 minus the payout ratio. See Lecture Notes 6. **Remark:** Both approaches are crude approximations. Lots of assumptions behind both estimates.

- **Real Options:** Cashflows should incorporate strategic decisions to be made during the life of the project or associated with the project (real options). See Lecture Notes 5.
- **Opportunity Costs:** When valuing a project that uses existing assets, you should factor alternative uses of these assets as a cost (opportunity costs).
- **Other Things to Keep in Mind:** Relating to NPV concept... See Lecture Notes 3.
- **Beware:** Problems with other valuation concepts (e.g. IRR, payback period).
- **IRR:** Not unique.  $IRR > r$  does not necessarily imply that the project has a positive NPV.
- **Payback Period:** Doesn't consider profitability after payback has been achieved. Makes growth projects look bad relative to stable ones. Some versions of the payback period also ignore the time value of money.

• **Investment and Expected Returns on Securities:**

- **Approach:** Investors care about the expected returns and variance of returns on their portfolio as a whole (i.e. pick portfolios on the capital market line (CML)).
- **Statistical Tools:** Expectation, variance, standard deviation, covariance, computing returns.
- **Expectation:** Think 'average'. We write the expected return of an asset  $i$  as  $E[r_i]$ .
- **Variance:** Measures how much variation there is in returns by taking the average of the squared deviations of returns from the average return:

$$V[r_i] = E[(r_i - E[r_i])^2].$$

- **Standard Deviation:** Measures something similar to variance. It's actually just the square root of variance. Sometimes called volatility in the context of stock returns.
- **Covariance:** Measures how two assets tend to move together (either in the same or opposite directions):

$$\text{Cov}(r_i, r_j) = E[(r_i - E[r_i])(r_j - E[r_j])].$$

The intuition of this formula is that covariance is positive (i.e.  $r_i$  and  $r_j$  tend to move together) if when  $r_i$  is better than average (i.e.  $r_i > E[r_i]$ ),  $r_j$  tends to do better than average as well (i.e.  $r_j > E[r_j]$ ).

- **Efficiency Frontier:** The curve representing the expected return and standard deviation of all optimal risky portfolios (i.e. minimum portfolio standard deviation for a given target level of return). If investors can only invest in risky financial assets (i.e. stocks, risky bonds, etc), then they should pick portfolios on the upper part of this frontier. All other portfolios are inside the frontier.
- **Capital Market Line:** If investors can also invest in the riskless asset, they will pick a portfolio on the CML. This line passes through the riskless asset and the tangency portfolio. All securities and portfolios must lie on or below the CML.
- **Portfolio Choice Made Easy:** If the CAPM assumptions hold, then all investors should invest in a combination of only two portfolios: 1) the riskless asset, and 2) the market portfolio (e.g. an index fund). This is a much simpler investment problem than thinking about how much to invest in every single asset!
- **Market Portfolio:** What's the market portfolio? Technically, it should include all risky financial assets. This includes bonds. However, for estimation of equity betas, we typically assume the market portfolio is the S&P500 or the value weighted market return (both are stock only indices). Note that this approach is, in theory, incorrect.
- **Diversification:** Combining assets in portfolios can reduce risk (even cancel risks if assets have negative covariance).
- **CAPM:** A pricing model. Represented by the security market line (SML):

$$E[r_i] = r_f + \beta_i(E[r_m] - r_f) \quad \text{where} \quad \beta_i = \frac{\text{Cov}(r_i, r_m)}{V[r_m]}$$

where  $r_m$  is the return on the market portfolio and  $\beta_i$  is asset  $i$ 's beta. Mainly says that investors shouldn't be compensated for risk that can be diversified away. Beta represents the risk that's left after efficient diversification.

- **Systematic vs. Idiosyncratic:** Systematic risk is given to us by beta and cannot be diversified away. Idiosyncratic risk can be diversified away. We can break up an individual asset's variance of returns into these two components:

$$r_i = \underbrace{r_f + \beta_i(r_m - r_f)}_{\text{moves w/ mkt}} + \underbrace{\epsilon_i}_{\text{doesn't}}$$

so

$$V[r_i] = \underbrace{\beta_i^2 V[r_m]}_{\text{syst.}} + \underbrace{V[\epsilon_i]}_{\text{idio.}}$$

If an asset has a lot of idiosyncratic risk, it's standard deviation gives a poor indication of the risks it forces investors to bear. Why? Because the only risk this security adds to an efficient portfolio is given by the systematic risk. The CAPM and portfolio theory say that idiosyncratic risk doesn't matter!

- **Beta:** Isn't given to us. We need to estimate it. Different approaches, but they all involve taking regressions.
- **Own Historical Data:** Can estimate beta using a regression of the asset's historical return with the market's historical return.
- **Comparables:** Can estimate beta using comparables, but need to know what is comparable. For instance, if the firms' business risks are similar, then you should estimate beta of equity of comparable firms and unlever these betas to get betas of assets. Take an average to get an estimate of beta of assets and relever this estimate with the firms capital structure.
- **Estimation Problems:** 1) Estimation error, and 2) Changing beta problem. See beginning of Recitation V notes.
- **Beta of a Portfolio:** Take a value weighted average of each individual asset beta. For example, if you have a portfolio invested 50% in a beta = 2 asset and 25% in a beta = 1 and a beta = 4 asset, then the beta of your portfolio is:

$$\beta_P = .5 \times 2 + .25 \times 1 + .25 \times 4 = 2.25.$$

- **Discount Rates for Capital Budgeting:**

- **Approach:** Use CAPM as a guideline to get beta of equity. Need to go from beta of equity (which is what we estimate using stock price data) to beta of a project. See section VIII.
- **Beta of Equity to Beta of Assets:** Need to unlever the beta. If debt is risk (i.e.  $\beta_D = 0$ ), then need to solve:

$$(0.8) \quad \beta_A = \frac{E}{D + E} \beta_E$$

Notice that  $\beta_A$  is typically less than  $\beta_E$ . More generally, if the debt is risky and has a positive beta (i.e.  $\beta_D > 0$ ), then need to solve:

$$(0.9) \quad \beta_A = \frac{D}{D + E} \beta_D + \frac{E}{D + E} \beta_E.$$

Beta of debt is less than beta of equity, so we still have that the beta of assets is less than the beta of equity. The intuition is that equity is the riskiest claim (and riskier than the whole package of claims) because it only gets what's left after the other claims are paid off.

- **Beta of Projects:** Use a comparables approach with a set of pure plays. See Recitation V notes.
- **Keep in Mind:** CAPM assumes no taxes. Need to make adjustments when taxes are taken into account. WACC:

$$WACC = \frac{D}{D + E} (1 - \tau_C) E[r_D] + \frac{E}{D + E} E[r_E].$$

The intuition is that  $E[r_D]$  and  $E[r_E]$  are what the debtholders and equityholders receive from their investment, but tax asymmetries cause the cost of debt to be lower than  $E[r_D]$  for the firm (the gov't effectively pays some of this cost) while no similar reduction of cost exists for equity. See Recitation V notes.

- **Beware:** Applying CAPM guidelines to long-term projects can be problematic due to the changing nature of risk for some projects. See B-M Chapter 9 (end of chapter).

- **Capital Structure:**

- **Question:** So you need cash to finance a project. Where do you get this cash? How do you raise it?
- **Capital Structure:** The mix of securities a firm has issued (e.g. secured debt, callable debt, common stock, preferred stock).
- **MM Theorem:** In a frictionless market, how you raise the cash doesn't matter. Capital structure doesn't effect the value of the firm.
- **Frictionless Market:** See Recitation VI notes.
- **Corporate Taxes:** Tax advantage of debt. If have  $D$  amount of debt and a cost of debt  $r_D$ , will owe  $r_D \times D$  in interest payments to debtholders next year. This payment reduces accounting profits and lowers next year's tax burden by:

$$\tau_C \times r_D \times D.$$

If the firm maintains a debt level of  $D$  forever, it will save the above amount in taxes every year. The value of these future tax saving, called the PV of future debt tax-shields, will be given by the perpetuity formula:

$$\tau_C \times D.$$

These tax savings should be reflected in the firm's value. See exercise in later part of Recitation VI notes. Notice that the tax savings are even higher if the firm increases its debt over time (e.g. may need to use the growing perpetuity formula).

- **Beware:** More debt implies more tax savings which increases firm value. Then we should only raise capital in external market with debt? Not quite. We've left out other details... there are some costs to debt. See below. The Massey Fergusson case provides a nice example of the potential hazards of leverage.
- **Costs of Financial Distress:** High debt leads to potential loss when in financial distress. These losses are due only to leverage (i.e. leverage can have an effect on operations!). See Recitation VI notes for a discussion of this.
- **Credit Ratings:** Cost of financial distress make raising debt more costly for highly levered firms than those with low debt levels. This is reflected by changes in a firm's credit rating. See Lecture 14 notes.
- **Static Tradeoff Theory:** Firms choose a capital structure that optimally balances the tax advantages of debt and the costs of financial distress. Points to an optimal amount of debt (which may vary from industry to industry and firm to firm).
- **Alternative Theories:** Pecking Order and Market Timing Theory of Capital Structure.
- **Pecking Order:** Firms have better information about firm prospects than investors. Investors are wary of being ripped off, so they're more willing to buy information insensitive securities like debt than information sensitive securities like equity. Points to a pecking order. Not a theory of optimal debt-equity ratio.
- **Market Timing:** Investors have fluctuating sentiment and, as a result, the firm's equity is occasionally overpriced or underpriced. When the firm raises capital, it will choose equity when its stock is overpriced and debt when the stock is underpriced. Similar to pecking order theory because managers have better information than investors, but dissimilar in the sense that investors in the market timing theory are more naive than those in the pecking order theory.
- **Evidence:** Points to a combination of the three theories. All above theories seem to be somewhat relevant.