Artificial Intelligence (AI) for Investments

Lesson 8: Cost of Capital

Introduction

In this lesson we will cover the following topics:

- Introduction Company and Project Cost of Capital
- Computing Company Cost of Capital
- Estimating the components of WACC
- Analyzing Project Risk
- Certainty Equivalents
- Summary and concluding remarks

Company and Project Cost of Capital

Company and Project Cost of Capital

- Company cost of capital is defined as the expected return on a portfolio of all the company's existing securities
  - It is the opportunity cost of capital for investment in the firm's assets
  - If the firm has no debt outstanding, then the company cost of capital is just the expected rate of return on the firm's stock
  - The company cost of capital is not the correct discount rate if the new projects are more or less risky than the firm's existing business
  - $Firm\ Value = PV(AB) = PV(A) + PV(B)$
  - The two discount rates will, in general, be different

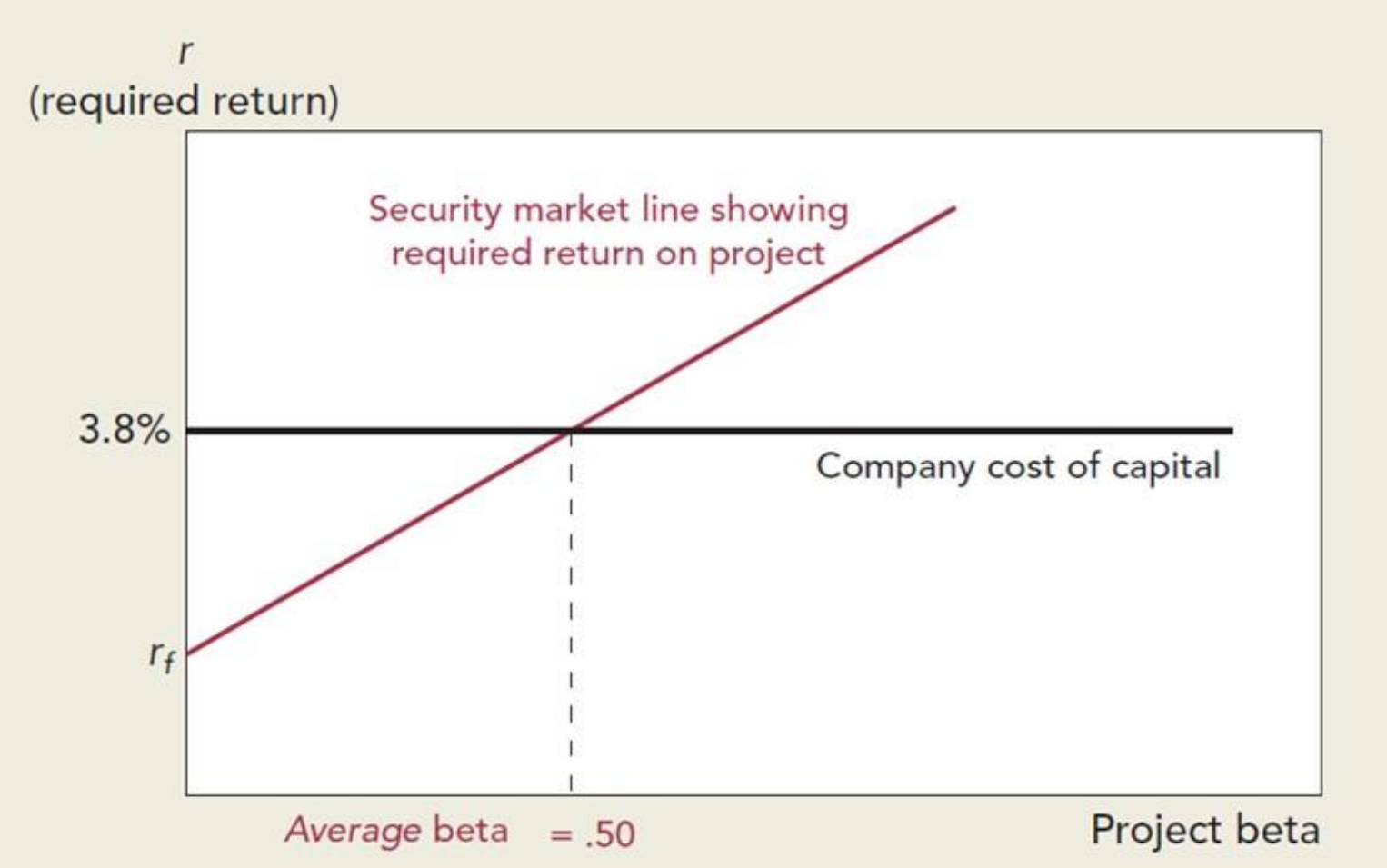
Company and Project Cost of Capital

- If the present value of an asset depended on the identity of the company that bought it, present values would not add up
  - Consider a portfolio of $1 million invested in firm A and $1 million invested in firm B
  - If the firm considers investing in a third project C, it should also value C as if C were a mini-firm
  - The opportunity cost of capital depends on the use to which that capital is put
  - A new division with different risk profile, considerable uncertainty and customer demand that is yet to be established, should of course have different cost of capital

Company and Project Cost of Capital

- Suppose we measure the risk of each project by its beta
  - Then a firm should accept any project lying above the upward-sloping security market line that links expected return to risk
  - If the project is high-risk, the firm needs a higher prospective return than if the project is low-risk
  - That is different from the company cost of capital rule, which accepts any project regardless of its risk as long as it offers a higher return than the company's cost of capital

Company and Project Cost of Capital



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Company and Project Cost of Capital

- The true cost of capital depends on project risk, not on the company undertaking the project
  - Why is so much time spent estimating the company cost of capital?
  - First, many (maybe most) projects can be treated as average risk
  - Second, the company cost of capital is a useful starting point for setting discount rates for unusually risky or safe projects
  - It is easier to add to, or subtract from, the company cost of capital

Company and Project Cost of Capital

- Businesspeople have good intuition about relative risks
  - They set a companywide cost of capital as a benchmark
  - Many large companies use the company cost of capital not just as a benchmark, but also as an all-purpose discount rate for every project proposal
  - Measuring differences in risk is difficult to do objectively
  - Top management may demand extra- conservative cash-flow forecasts from extra-risky projects
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Computing Company Cost of Capital

Computing Company Cost of Capital

- Company cost of capital is the expected return on a portfolio of all the company's existing securities
  - The portfolio of company security usually includes debt as well as equity
  - Thus the cost of capital is estimated as a blend of the cost of debt

Asset value	100	Debt	$D = 30$ at 7.5%
		Equity	$E = 70$ at 15%
Asset value	100	Firm value	$V = 100$

  - The values of debt and equity add up to overall firm value

Computing Company Cost of Capital

- The company cost of capital is not equal to the cost of debt or to the cost of equity but is a blend of the two
  - Suppose you purchased a portfolio consisting of 100% of the firm's debt and 100% of its equity
  - The expected rate of return on your hypothetical portfolio is the company cost of capital
  - The expected rate of return is just a weighted average of the cost of debt $(r_D = 7.5\%)$ and the cost of equity $(r_E = 15\%)$
  - The weights are the relative market values of the firm's debt and equity, that is, $D/V = 30\%$ and $E/V = 70\%$

Computing Company Cost of Capital

- The company cost of capital is not equal to the cost of debt or to the cost of equity but is a blend of the two
  - The marginal corporate tax rate $T_C = 35\%$
  - $\text{WACC or Company cost of capital} = r_D * (1 - T_c) * \frac{D}{V} + r_E * \frac{E}{V} = 7.5\% * (1 - 0.35) * 0.30 + 15 * 0.70 = 12.00\%$
  - This blended measure of the company cost of capital is called the weighted-average cost of capital or WACC

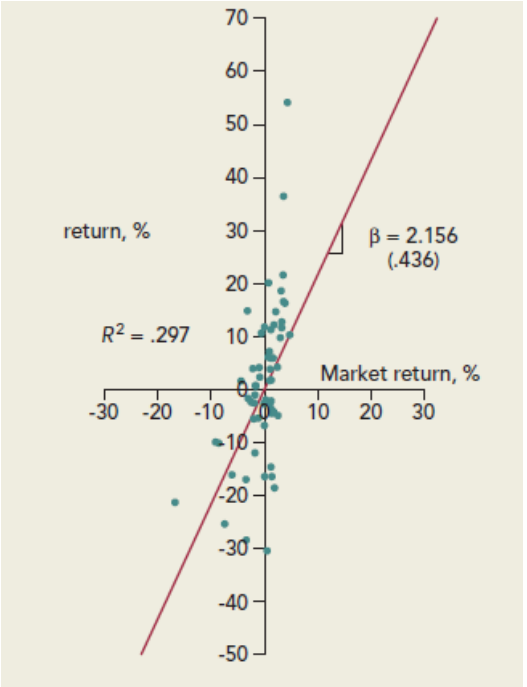
Estimating the components of WACC

Estimating the components of WACC

- To calculate the weighted-average cost of capital, you need an estimate of the cost of equity
  - We will use the capital asset pricing model (CAPM) to estimate the cost of equity
  - CAPM: $Expected\ Returns = r_f + \beta(r_m - r_f)$
  - In principle we are interested in the future beta of the company's stock
  - We will estimate beta using historical security price data

Estimating the components of WACC

- In the scatter diagram shown here, each dot represents the return on a security and return on market
  - The slope of fitted line is called beta
  - The R-square measure tells the proportion of total variance that can be explained by market variance
  - It appears that 29.7% of the variance was was explained by the market
  - The 95% confidence interval estimate of beta is 2.16



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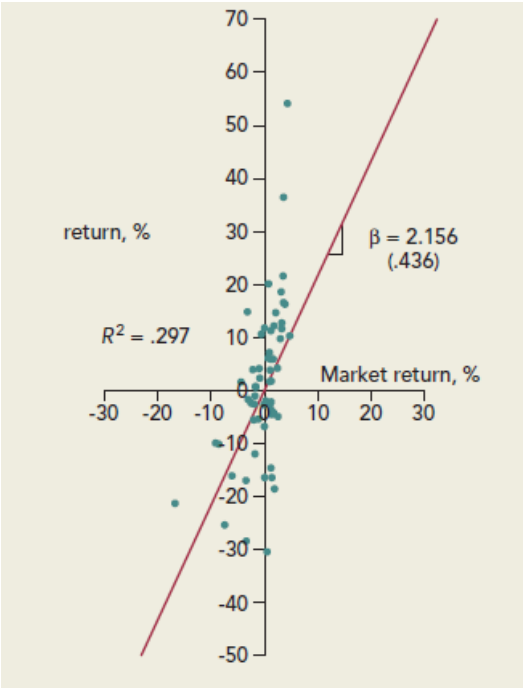
Estimating the components of WACC

- In the scatter diagram shown here, each dot represents the return on a security and return on market
  - Standard error of the estimated beta is computed to show the extent of possible mismeasurement
  - Standard error of beta estimate is 0.436
  - The 95% confidence interval estimate 2.16 plus or minus 2*0.436
  - That is, you have 95% chance of being right in saying that beta can fall in this interval



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Estimating the components of WACC

- How to estimate the risk-free rate of interest (r_f)
  - Should we use short-term treasury bill rate, daily over night rate, monthly rate, one year interest rate or long-term interest rates
  - CAPM is a short-term model
  - It works period by period and calls for a short-term interest rate
  - Could a .2% three-month risk-free rate give the right discount rate for cash flows 10 or 20 years in the future?

Estimating the components of WACC

- How to estimate the risk-free rate of interest (r_f)
  - Financial managers can simply use a long-term risk-free rate in the CAPM formula
  - Or, they can compute the term premia (for investing in long-term government bonds – T-Bills) =1.5%
  - The difference in current Govt. bond yields (e.g., 3.3%) and this term premia reflects that short-term T-Bill rates= 3.3%-1.5%=1.8%
  - If the market risk-premium in 7%, beta is 1.16, then the cost of equity can be computed as follows. $Cost\ of\ equity = Expected\ Returns = r_f + \beta(r_m - r_f) = 1.8 + 1.16 * 7.0 = 9.9\%$

Estimating the components of WACC

- Estimating cost of equity and WACC
  - If the market risk-premium in 7%, beta is 1.16, then the cost of equity can be computed as follows. $Cost\ of\ equity = Expected\ Returns = r_f + \beta(r_m - r_f) = 1.8 + 1.16 * 7.0 = 9.9\%$
  - Let us calculate the WACC for a firm with cost of Debt of about 7.8%, corporate tax-rate of 35%, and debt ratio (D/V) of 31.5%.
  - $After\ Tax\ WACC = (1 - T_C) * r_D * \frac{D}{V} + r_E * \frac{E}{V} = (1 - 0.35) * 7.8 * 0.315 + 9.9 * 0.685 = 8.4\%$

Estimating the components of WACC

- The cost of debt is always less than the cost of equity
  - The WACC formula blends the two costs: Debt and Equity
  - As the debt ratio D/V increases, the cost of the remaining equity also increases
  - This offsets offsetting the apparent advantage of more cheap debt
  - Debt does have a tax advantage, however, because interest is a tax-deductible expense

Estimating the components of WACC

- The after-tax WACC depends on the average risk of the company's assets, but it also depends on taxes and financing
  - It's easier to think about project risk if you measure it directly
  - As the debt ratio D/V increases, the cost of the remaining equity also increases
  - We calculate the asset beta as a blend of the separate betas of debt (β_D) and equity (β_E)
- For example, let us consider a security with $\beta_E = 1.16$ and $\beta_D = 0.3$. The weights are the fractions of debt and equity financing, $D/V = .315$ and $E/V = .685$

Estimating the components of WACC

- The after-tax WACC depends on the average risk of the company's assets, but it also depends on taxes and financing
  - For example, let us consider a security with β_E=1.16 and β_D = 0.3. The weights are the fractions of debt and equity financing, D/V= .315 and E/V =.685
  - Asset beta= $\beta_A = \beta_D * \left(\frac{D}{V}\right) + \beta_E * \left(\frac{E}{V}\right) = 0.3 * 0.315 + 1.16 * 0.685 = 0.89$
  - Calculating an asset beta is similar to calculating a weighted-average cost of capital
  - This asset beta is an estimate of the average risk of the firm's business

Analyzing Project Risk

Analyzing Project Risk

- Suppose that a coal-mining corporation wants to assess the risk of investing in commercial real estate
  - The asset beta for coal mining is not helpful
  - You need to know the beta of real estate
  - A company that wants to set a cost of capital for one particular line of business typically looks for pure plays in that line of business
  - Pure-play companies are public firms that specialize in one activity

Analyzing Project Risk

- Schlumberger wants to set a cost of capital for its new Oil exploration venture
  - It could estimate the average asset beta or cost of capital for Oil and Gas firms that have not diversified into multiple business lines (e.g., Reliance)
  - They should not consider Reliance group as it would have multiple companies in different groups
  - ONGC would be a pure-play and suitable for estimating the cost of capital
  - Many times good comparable pure plays are not available, then we go for asset betas

Analyzing Project Risk

- What determines asset betas?
  - **Cyclicality:** What is the strength of the relationship between the firm's earnings and aggregate market earnings
  - We can measure this either by the earnings beta or by the cash-flow beta
  - Cyclical firms—firms whose revenues and earnings are strongly dependent on the state of the business cycle—tend to be high-beta firms
  - Cyclical businesses include airlines, luxury resorts and restaurants, construction, and steel

Analyzing Project Risk

- What determines asset betas?
  - **Operating Leverage:** A production facility with high fixed costs, relative to variable costs, is said to have high operating leverage
  - High operating leverage means a high asset beta
  - Cash flow = revenue - fixed cost - variable cost
  - Fixed costs are cash outflows that occur regardless of whether the asset is active or idle
  - PV(asset)= PV(revenue)- PV(fixed cost) – PV(variable cost)

Analyzing Project Risk

- What determines asset betas?
  - **Operating Leverage:** PV(revenue) = PV(fixed cost)+ PV(variable cost)+PV(Asset)
  - $\beta_{revenue} = \beta_{fixedcost} * \frac{PV(fixedcost)}{PV(Revenue)} + \beta_{variablecost} * \frac{PV(variablecost)}{PV(Revenue)} + \beta_{asset} * \frac{PV(variable)}{PV(Revenue)}$
  - $\beta_{asset} = \beta_{revenue} * \frac{PV(revenue) - PV(variablecost)}{PV(Asset)} = \beta_{revenue}[1 + \frac{PV(fixedcost)}{PV(Asset)}]$
  - Given the cyclicality of revenues ($\beta_{revenue}$), the asset beta (β_{asset}) is proportional to the ratio of the present value of fixed costs to the present value of the project

Analyzing Project Risk

- What determines asset betas?
  - Don’t Be Fooled by Diversifiable Risk
  - In everyday usage, “risk” simply means “bad outcome”
  - People think of the risks of a project as a list of things that can go wrong
  - Risks such as a pharma-company finding side-effects of a new drug are diversifiable risks
  - Thus, these hazards should not affect the discount rates

Analyzing Project Risk

- Sometimes financial managers increase discount rates in an attempt to offset these risks
  - Consider a project Z that produces just one cash flow, forecasted at $1 million at year 1
  - $PV = \frac{C_1}{1+r} = \frac{100000}{1.1} = 909{,}100$
  - Company discovers a small hazard, which may cause a small chance that project will have zero cash flow
  - The appropriate way to deal with this situation is to prepare unbiased cash flow forecasts that give due weight to all possible outcomes

Analyzing Project Risk

- Managers making unbiased forecasts are correct on average
  - Sometimes their forecasts will turn out high, other times low, but their errors will average out over many projects
  - The appropriate way to deal with this situation is to prepare unbiased cash flow forecasts that give due weight to all possible outcomes
  - . If you forecast a cash flow of $1 million for projects like Z, you will overestimate the average cash flow

Possible Cash Flow	Probability	Probability-Weighted	Unbiased Forecast
1.2	0.25	0.3	$1 million
1	0.5	0.5	
0.8	0.25	0.2	

Analyzing Project Risk

- Managers making unbiased forecasts are correct on average
  - If technological uncertainty introduces a 10% chance of a zero cash flow, the unbiased forecast could drop

Possible Cash Flow	Probability	Probability-Weighted	Unbiased Forecast
1.2	0.25	0.27	$0.90 million
1	0.45	0.45	
0.8	0.225	0.18	
0.0	0.10	0.00	

  - Thus, the new present value computation would be: $PV = \frac{0.90}{1.1} = \$0.818 \text{ million}$

Analyzing Project Risk

- Managers often work out a range of possible outcomes for major projects, sometimes with explicit probabilities attached
  - The manager can still consider the good and bad outcomes as well as the most likely one
  - When the bad outcomes outweigh the good, the cash-flow forecast should be reduced until balance is regained
  - Step 1, then, is to do your best to make unbiased forecasts of a project's cash flows
  - Step 2 is to consider whether diversified investors would regard the project as more or less risky than the average project

Certainty Equivalents

Certainty Equivalents

- Discount rates are not constant and constantly change over the project life as the project risk changes
  - You are considering construction of an office building that you plan to sell after one year for $420,000
  - That cash flow is uncertain with the same risk as the market, so β=1
  - Given r_f =5% and $r_m - r_f$ =7%, you compute the present value as: 420,000/1.12 = $375,000
  - What is that certain payoff you are willing to accept to sell the project in future
  - $PV = \frac{Certain\ cash\ flow}{1.05} = 375000$, Certain cash flow= $393,750

Certainty Equivalents

- Discount rates are not constant and constantly change over the project life as the project risk changes
  - Thus, a certain cash flow of $393,750 has exactly the same present value as an expected but uncertain cash flow of $420,000
  - To compensate for both the delayed payoff and the uncertainty in real estate prices, you need a return of 420,000 - 375,000 = $45,000
  - One part of this difference compensates for the time value of money
  - The other part ($420,000 -393,750 = $26,250) is a markdown or haircut to compensate for the risk attached to the forecasted cash flow of $420,000.

Certainty Equivalents

- How to value risky project cash flows
  - Method 1: Discount the risky cash flow at a risk-adjusted discount rate r that is greater than r_f
  - Method 2: Find the certainty-equivalent cash flow and discount at the risk-free interest rate r_f
  - What is the smallest certain payoff for which I would exchange the risky cash flow, this is called certainty equivalent (CEQ)

Certainty Equivalents

- Thus, We now have two identical expressions for the PV of a cash flow
  - At period 1, $PV = \frac{C_1}{1+r} = \frac{CEQ}{1+r_f}$
  - For cash flows two, three, or t years away, $PV = \frac{C_t}{(1+r)^t} = \frac{CEQ}{(1+r_f)^t}$

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Certainty Equivalents

- Consider two simple projects
  - Project A is expected to produce a cash flow of $100 million for each of three years. The risk-free interest rate is 6%, the market risk premium is 8%, and project A's beta is .75
  - Cost of capital for A as per CAPM: $= r_f + \beta(r_m - r_f) = 6 + 8 * 0.75 = 12\%$

Year	Cash Flow	PV at 12%
1	100	89.3
2	100	79.7
3	100	71.2 **Total PV 240.2**

Certainty Equivalents

- Consider two simple projects
  - Project B is a safe project and the cash flows can be discounted at risk-free rate
  - The discounted cash flows are shown here

Year	Cash Flow	PV at 6%
1	94.6	89.3
2	89.6	79.7
3	84.8	71.2
		Total PV 240.2

Certainty Equivalents

- Risk-free cash flow vs. certainty equivalents
  - In year 1 project A has a risky cash flow of 100. This has the same PV as the safe cash flow of 94.6 from project B
  - In year 2 project A has a risky cash flow of 100, and B has a safe cash flow of 89.6

Year	Forecasted Cash Flow	Certainty-Equivalent	Deduction for Risk
1	100	94.6	5.4
2	100	89.6	10.4
3	100	84.8	15.2

Summary and Concluding remarks

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- If the project has the same risk as the average company risk, then company cost of capital is good benchmark to discount project cash flows
- Company cost of capital is measured with after-tax weighted-average cost of capital (after-tax WACC)
- When the project risk is considerably different from average company risk, then asset betas are often employed t estimate the project risk
- Overtime as the project risk changes, discount rates also change
- In such scenarios, we may use certainty equivalents (CEQ) to discount at risk-free rate to value the project

Thanks!