CHAPTER 9

RISK AND THE COST OF CAPITAL

Topics Covered

- Company and Project Costs of Capital
- Measuring the Cost of Equity
- Analyzing Project Risk
- Certainty Equivalents - Another Way to Adjust for Risk

Company Cost of Capital

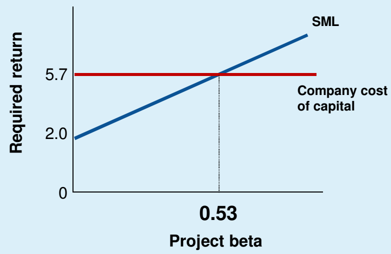
- A firm's value can be stated as the sum of the value of its various assets
- "The value-additivity principle"

$$\text{Firm value} = \text{PV(AB)} = \text{PV(A)} + \text{PV(B)}$$

Company Cost of Capital

9-4

- A company's cost of capital can be compared to the CAPM required return



Company Cost of Capital

9-5

$$r_{assets} = COC = r_{debt}\left(\frac{D}{V}\right) + r_{equity}\left(\frac{E}{V}\right)$$

$V = D + E$
D = market value of debt
E = market value of equity

IMPORTANT

E, *D*, and *V* are all market values of equity, debt and total firm value

$$r_{debt} = \text{YTM on bonds}$$
$$r_{equity} = r_f + B(r_m - r_f)$$

Weighted Average Cost of Capital

9-6

WACC is the traditional view of capital structure, risk and return

$$WACC = (1 - T_c)r_D\left(\frac{D}{V}\right) + r_E\left(\frac{E}{V}\right)$$
$$WACC = (1 - .35)7.5(.30) + 15(.70)$$
$$= 12.0\%$$

Capital Structure and Equity Cost

9-7

Capital structure - the mix of debt & equity within a company

Expand CAPM to include capital structure:

$$r = r_f + \beta(r_m - r_f)$$

This becomes:

$$r_{equity} = r_f + \beta(r_m - r_f)$$

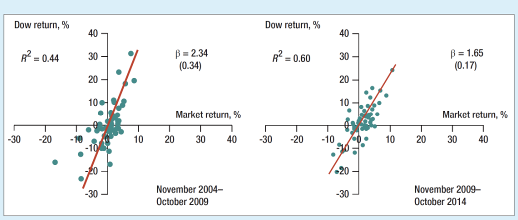
Measuring Betas

9-8

- The SML shows the relationship between return and risk
- CAPM uses beta as a proxy for risk
- Other methods can be employed to determine the slope of the SML and thus beta
- Regression analysis can be used to find beta

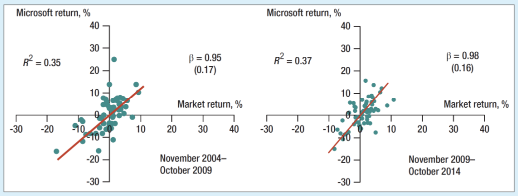
Measuring Betas

9-9



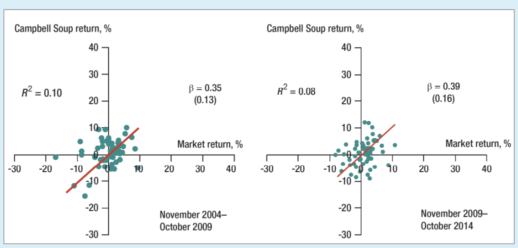
Measuring Betas

9-10



Measuring Betas

9-11



Estimated Betas

9-12

	Beta	Standard Error
Canadian Pacific	1.34	0.19
CSX	1.34	0.14
Kansas City Southern	1.27	0.20
Genesee & Wyoming	1.34	0.19
Norfolk Southern	1.16	0.16
Union Pacific	0.98	0.12
Industry portfolio	1.24	0.12

Beta Stability

9-13

Risk Class	% in Same Class 5 Years Later	% within One Class 5 Years Later
10 (High betas)	35	69
9	18	54
8	16	45
7	13	41
6	14	39
5	14	42
4	13	40
3	16	45
2	21	61
1 (Low betas)	40	62

Source: Sharpe and Cooper (1972)

Company Cost of Capital

9-14

Company cost of capital (COC) is based on the average beta of the assets

The average beta of the assets is based on the % of funds in each asset

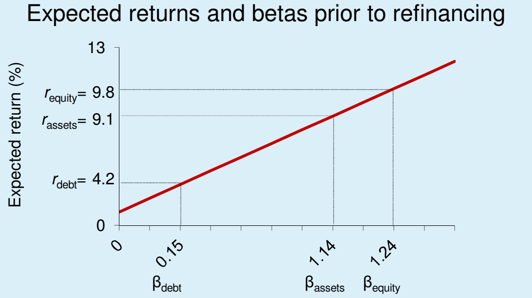
Assets = debt + equity

$$\beta_{\text{assets}} = \beta_{\text{debt}} \times \left(\frac{D}{V}\right) + \beta_{\text{equity}} \times \left(\frac{E}{V}\right)$$

Capital Structure and COC

9-15

Expected returns and betas prior to refinancing



Company Cost of Capital: Simple Approach

Company cost of capital (COC) is based on the average beta of the assets

The average beta of the assets is based on the % of funds in each asset

Example

1/3 New ventures β = 2.0
1/3 Expand existing business β = 1.3
1/3 Plant efficiency β = 0.6

Average β of assets = 1.3

Company Cost of Capital

Category	Discount Rate
Speculative ventures	15.0%
New products	8.0%
Expansion of existing business	3.8% (Company COC)
Cost improvement, known technology	2.0%

Asset Betas

$$\beta_{\text{revenue}} = \beta_{\text{fixed cost}} \frac{\text{PV(fixed cost)}}{\text{PV(revenue)}} + \beta_{\text{variable cost}} \frac{\text{PV(variable cost)}}{\text{PV(revenue)}} + \beta_{\text{asset}} \frac{\text{PV(asset)}}{\text{PV(revenue)}}$$

Asset Betas

9-19

$$\beta_{asset} = \beta_{revenue} \frac{\text{PV(revenue) - PV(variable cost)}}{\text{PV(asset)}}$$

$$= \beta_{revenue} \left[1 + \frac{\text{PV(fixed cost)}}{\text{PV(asset)}} \right]$$

Allowing for Possible Bad Outcomes

9-20

Example

Project Z will produce just one cash flow, forecasted at $1 million at year 1. It is regarded as average risk, suitable for discounting at a 10% company cost of capital:

$$\text{PV} = \frac{C_1}{1+r} = \frac{1{,}000{,}000}{1.1} = \$909{,}100$$

Allowing for Possible Bad Outcomes

9-21

Example- continued

But now you discover that the company's engineers are behind schedule in developing the technology required for the project. They are confident it will work, but they admit to a small chance that it will not. You still see the most likely outcome as $1 million, but you also see some chance that project Z will generate zero cash flow next year.

Possible Cash Flow	Probability	Probability-Weighted Cash Flow	Unbiased Forecast
1.2	0.25	0.3	
1.0	0.50	0.5	1.0, or $1 million
0.8	0.25	0.2	

Allowing for Possible Bad Outcomes

9-22

Example- continued

This might describe the initial prospects of project Z. But if technological uncertainty introduces a 10% chance of a zero cash flow, the unbiased forecast could drop to $900,000.

Possible Cash Flow	Probability	Probability-Weighted Cash Flow	Unbiased Forecast
1.2	0.225	0.27	
1.0	0.45	0.45	0.90, or $900,000
0.8	0.225	0.18	
0	0.10	0.0	

$$PV = \frac{900{,}000}{1.1} = \$818{,}000$$

Correcting for Optimistic Forecasts

9-23

Year:	1	2	3	4	5	. . .	10	. . .	15
1. Original cash-flow forecast	$1,000.00	$1,000.00	$1,000.00	$1,000.00	$1,000.00	. . .	$1,000.00	. . .	$1,000.00
2. PV at 12%	$ 892.90	$ 797.20	$ 711.80	$ 635.50	$ 567.40	. . .	$ 322.00	. . .	$ 182.70
3. Corrected cash-flow forecast	$ 900.00	$ 900.00	$ 900.00	$ 900.00	$ 900.00	. . .	$ 900.00	. . .	$ 900.00
4. PV at 12%	$ 803.60	$ 717.50	$ 640.60	$ 572.00	$ 510.70	. . .	$ 289.80	. . .	$ 164.40
5. PV correction	– 10.0%	– 10.0%	– 10.0%	– 10.0%	– 10.0%	. . .	– 10.0%	. . .	– 10.0%
6. Original forecast discounted at 22%	$ 819.70	$ 671.90	$ 550.70	$ 451.40	$ 370.00	. . .	$ 136.90	. . .	$ 50.70
7. PV "correction" at 22% discount rate	– 8.2%	– 15.7%	– 22.6%	– 29.0%	– 34.8%	. . .	– 57.5%	. . .	– 72.3%

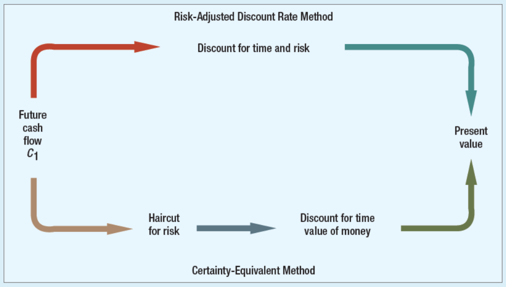
Risk, DCF, and CEQ

9-24

$$PV = \frac{C_t}{(1+r)^t} = \frac{CEQ_t}{(1+r_f)^t}$$

Risk, DCF, and CEQ

9-25



Risk, DCF, and CEQ

9-26

Example

Project A is expected to produce CF = $100 mil for each of three years. Given a risk free rate of 6%, a market premium of 8%, and beta of .75, what is the PV of the project?

$$r = r_f + \beta(r_m - r_f)$$
$$= 6 + .75(8)$$
$$= 12\%$$

Risk, DCF, and CEQ

9-27

Example

Project A is expected to produce CF = $100 mil for each of three years. Given a risk free rate of 6%, a market premium of 8%, and beta of .75, what is the PV of the project?

$$r = r_f + \beta(r_m - r_f)$$
$$= 6 + .75(8)$$
$$= 12\%$$

Project A

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

Risk, DCF, and CEQ

9-28

Example

Project A is expected to produce CF = $100 mil for each of three years. Given a risk free rate of 6%, a market premium of 8%, and beta of .75, what is the PV of the project?

Project A		
Year	Cash Flow	PV @ 12%
1	100	89.3
2	100	79.7
3	100	71.2
	Total PV	240.2

Now assume that the cash flows change, but are RISK FREE. What is the new PV?

$$r = r_f + \beta(r_m - r_f)$$
$$= 6 + .75(8)$$
$$= 12\%$$

Risk, DCF, and CEQ

9-29

Example

Project A is expected to produce CF = $100 mil for each of three years. Given a risk free rate of 6%, a market premium of 8%, and beta of .75, what is the PV of the project? Now assume that the cash flows change, but are RISK FREE. What is the new PV?

Project A		
Year	Cash Flow	PV @ 12%
1	100	89.3
2	100	79.7
3	100	71.2
	Total PV	240.2

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

Risk, DCF, and CEQ

9-30

Example

Project A is expected to produce CF = $100 mil for each of three years. Given a risk free rate of 6%, a market premium of 8%, and beta of .75, what is the PV of the project? Now assume that the cash flows change, but are RISK FREE. What is the new PV?

Project A		
Year	Cash Flow	PV @ 12%
1	100	89.3
2	100	79.7
3	100	71.2
	Total PV	240.2

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

Since the 94.6 is risk free, we call it a ***certainty equivalent*** of the 100.

Risk, DCF, and CEQ

9-31

Example

Project A is expected to produce CF = $100 mil for each of three years. Given a risk free rate of 6%, a market premium of 8%, and beta of .75, what is the PV of the project? DEDUCTION FOR RISK.

Year	Cash Flow	CEQ	Deduction for Risk
1	100	94.6	5.4
2	100	89.6	10.4
3	100	84.8	15.2

Risk, DCF, and CEQ

9-32

Example

Project A is expected to produce CF = $100 mil for each of three years. Given a risk free rate of 6%, a market premium of 8%, and beta of .75, what is the PV of the project? Now assume that the cash flows change, but are RISK FREE. What is the new PV?

The difference between the 100 and the certainty equivalent (94.6) is 5.4%…this % can be considered the annual premium on a risky cash flow

$$\frac{\text{Risky cash flow}}{1.054} = \text{certainty equivalent cash flow}$$

Risk, DCF, and CEQ

9-33

Example

Project A is expected to produce CF = $100 mil for each of three years. Given a risk free rate of 6%, a market premium of 8%, and beta of .75, what is the PV of the project? Now assume that the cash flows change, but are RISK FREE. What is the new PV?

$$\text{Year 1} = \frac{100}{1.054} = 94.6$$

$$\text{Year 2} = \frac{100}{1.054^2} = 89.6$$

$$\text{Year 3} = \frac{100}{1.054^3} = 84.8$$