

The Capital Asset Pricing Model (CAPM)

Bernt Arne Ødegaard

30 August 2023

Contents

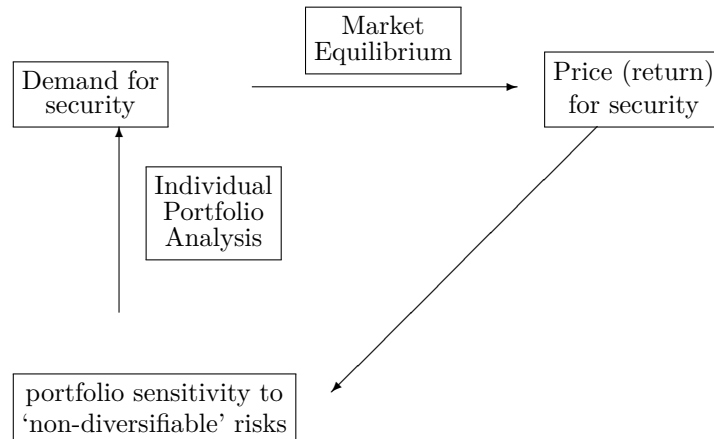
1 Introduction	1
2 Basic lesson of the CAPM.	2
3 Some examples, CAPM usage	2
4 Capital budgeting and the CAPM.	2
4.1 Company cost of capital	2
5 CAPM and combinations of assets (portfolios)	3
5.1 Identifying mispriced stocks	4
6 Use of betas in practice	4
6.1 Estimating betas from market data	4
6.2 Industry betas	4
7 Different betas for debt and equity.	5

1 Introduction

Lecture overview:

- Intuition: What is an asset pricing model? What do we use it for?
- Equilibrium consequence of mean-variance analysis: CAPM
- Using the CAPM: Cost of capital.
- Corporate use of CAPM: Cost of equity and cost of debt

2 Basic lesson of the CAPM.



3 Some examples, CAPM usage

4 Capital budgeting and the CAPM.

The CAPM can also be useful for determining the discount rates on new investment projects.

4.1 Company cost of capital

Exercise 1.

A project has the following forecasted cash flows:

$t =$	0	1	2	3
$C_t =$	-100	40	60	50

The estimated project beta is 1.5. The expected market return $E[r_m]$ is 16%, and the risk free rate r_f is 7%.

1. Estimate the opportunity cost of capital for the project.
2. Calculate the project NPV.

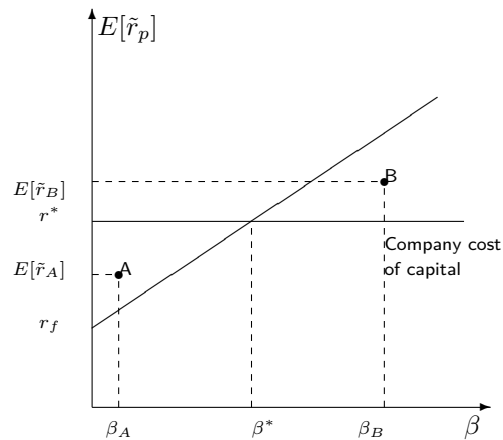
Many firms discount the cash flows on new investment projects by the *company-wide cost of capital*. According to the CAPM, the required rate of return on the firm's equity is given by

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

where β^* is the firms *asset beta*.

Exercise 2.

A firm is considering investing in two investment projects, A and B. Project A has a low beta, and project B has a high beta. The returns of the projects are illustrated in the following figure, which also shows the Security Market Line. In the figure we also show the company-wide cost of capital used for the firm to evaluate investments.



1. Which project should be undertaken?

Exercise 3.

A firm currently own assets worth \$4 mill that have a beta of 1. The risk free interest rate is 10% and the market risk premium is 8%. Suppose the firm has the opportunity to invest in a project that will earn a 13% rate of return for certain into the indefinite future. The cost of the project is \$1 mill. Should the firm make the investment?

Exercise 4.

A firm owns \$4 million of Treasury bills that yield 10%. The firm has no other assets, but is contemplating issuing \$1 mill of equity to finance a new investment project that has a beta of 1.0 and is expected to earn an annual return of 15%. The market risk premium is 8%. Should the firm make the investment?

5 CAPM and combinations of assets (portfolios)

A very useful feature of CAPM is that it is linear in betas.

$$\beta_p = \sum_i \omega_i \beta_i$$

One could alternatively look at the returns directly

$$E[r_i] = r_f + \beta_i(E[r_m] - r_f)$$

$$E[r_p] = \sum \omega_i E[r_i]$$

Exercise 5.

You are given the following information about your portfolio

Stock	beta β_i	weight ω_i
A	1.25	0.25
B	1.00	0.50
C	0.75	0.25

Let $E[\tilde{r}_m] = 10\%$ and $r_f = 5\%$.

1. How do we calculate the expected return on this portfolio?

5.1 Identifying mispriced stocks

Exercise 6.

Suppose you are the manager of an investment fund in a CAPM world. Ignore taxes. Given the following forecast:

$$E[\tilde{r}_m] = 16\%$$

$$\sigma(r_m) = 0.20$$

$$r_f = 8\%$$

1. Would you recommend investment in a security j with the following characteristics: $E[\tilde{r}_j] = 12\%$ and $\text{cov}(\tilde{r}_j, \tilde{r}_m) = 0.01$?
2. Suppose next period it turns out that this security j has had a return of only 5%. How would you explain this, given that $E[\tilde{r}_j] = 12\%$?

6 Use of betas in practice

There is a variety of problems with the estimation of betas for individual projects of divisions within the company:

1. Betas may change over time.
 - [-] Due to estimation errors.
 - [-] Due to changes in the underlying risk characteristics of the firm.
2. Determining the appropriate time period to do the estimation.
3. If you want to estimate the beta for a new investment project, you would have no past information about how the returns on the new project covary with the market.

6.1 Estimating betas from market data

A typical way of estimating betas is to use stock market data, and estimate the implied beta from historical returns data.

6.2 Industry betas

An alternative method for estimating the beta for a new project or for a division is to use a beta estimate for the industry to which the project belongs. These industry betas are often more reliable than the estimates for individual firms and should provide a relatively good measure of the project or division's market risk.

Industry	Beta
Electronic components	1.49
Crude petroleum and natural gas	1.07
Retail department stores.	.95
Chemicals	.89
Food	.84
Trucking	.83
Paper and allied products	.82
Airlines	.75
Steel	.66
Railroads	.61
Telephone companies	.50
Electric utilities	.46

7 Different betas for debt and equity.

The beta that is used to compute the discount rate or opportunity cost of capital for new investment project is the project's *asset beta*.

Unfortunately, *asset betas* are not directly observable, only *equity betas* are observable.

In the case where the firm uses leverage, the *asset beta* β^* , will be a weighted average of the betas on the firm's debt and equity.

The *asset beta* is given by:

$$\beta^* = \beta_D \cdot \frac{D}{V} + \beta_E \cdot \frac{E}{V}$$

where

$$\begin{aligned}\beta_D &= \text{Beta of the firm's debt.} \\ D &= \text{Market value of the firm's debt.} \\ E &= \text{Market value of the firm's equity.} \\ V &= D + E\end{aligned}$$

The cost of capital for a levered firm is

$$\begin{aligned}r &= r_f + (r_m - r_f)\beta^* \\ &= r_D \cdot \frac{D}{V} + r_E \cdot \frac{E}{V}\end{aligned}$$

where r_D and r_E are the required rates of return on the firm's debt and equity, respectively.

Exercise 7.

	β	Market value
Debt	0.05	100
Equity	1.40	200

$$E[\tilde{r}_m] = 10\%$$

$$r_f = 5\%$$

1. What is the asset beta β^* ?
2. Find the firm's cost of capital

References