CAPM in practice

Lecture 5

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Table of contents

Investment strategies

Principle CAPM-based investment strategies

Strategy 1: Determination of the tangency porfolio

Strategy 2: Estimating betas

Strategy 3: Indexing

Section 2

Determination of tangency porfolio

Strategy 1: Determination of tangency porfolio

Problem: With a reasonable number of securities, the number of parameters to be estimated is huge

For a portfolio of $n = 100$ securities we need:

σ_i	n	100
μ_i	n	100
$\text{COV}(R_i, R_j)$	$0.5 \cdot n \cdot (n-1)$	4,950

About how much data will we need when we have 500 securities? 1,000 securities?

Strategy 1: Determination of tangency porfolio

Problem: Means and covariances are estimated with error.

- To estimate all μ_i and $\sigma_{i,j}$, we could use past empirical data.
  - What does the past tell us about the future?
- Small errors in mean or covariance estimates often lead to unreasonable weights.

Strategy 2: Estimating betas

Linear regression

Estimating β by means of linear regression

$$\tilde{r}_{i,t} - r_{0,t} = \alpha_i + \beta_i \cdot (\tilde{r}_{M,t} - r_{0,t}) + \varepsilon_{i,t}$$

for some time period

$$t = 1, 2, \ldots, T$$

with

$\tilde{r}_{i,t}$ historical return of asset i

$\tilde{r}_{M,t}$ historical return of market porfolio

$r_{0,t}$ risk-free return

Strategy 2: Estimating betas

Linear regression

Estimating β by means of linear regression

- To estimate this, typically we would use monthly data
- Typically use 5 years (60 months) of data.
  - Why not use more data? (10 or 20 years) – Parameter instability.
  - Can we use weekly, daily, or intraday data? – Non-synchronous prices, bid-ask bounce

Strategy 2: Estimating betas

Estimating betas of new companies

Estimating β in the absence of historical data: Find a similar company that is traded on an exchange and use the β of that company

- Which characteristics to use?
  - Industry
  - Firm Size
  - Financial leverage (refers to ratio of debt and equity)
  - Operating leverage (refers to ratio of fixed costs to variable costs)
  - Growth / value
- But often a comparable company cannot be found.

Strategy 2: Estimating betas

Estimating betas of new companies

Estimating β in the absence of historical data: Multiple linear regression

- Take a sample of companies that belong to the same industry as the new company.
- Estimate $\beta_{i,t}$ for these companies using historical return data.
- Regress estimated $\beta_{i,t}$ on several characteristics that can drive betas. Example:

$$\begin{aligned}\beta_{i,t} = \alpha_0 \quad & +\alpha_1 \cdot \text{FLEV}_{i,t} \\ & +\alpha_2 \cdot \text{SIZE}_{i,t} \\ & +\alpha_3 \cdot \text{OLEV}_{i,t} + \varepsilon_{i,t}\end{aligned}$$

Strategy 2: Estimating betas

Estimating betas of new companies

Betas may change over time, thus we use short windows of data (5-years)

Possible reasons for this are

1. changes in the firmâs leverage
2. changes in the type of a firmâs operations
3. the firm acquires targets in other industries

We can use rolling window regressions to estimate a time series of β.

Section 4

Indexing

Strategy 3: Indexing

Definition (Indexing)

Strategy of matching a portfolio of risky assets to a popular index.

Indexing is a passive strategy

- 'Acceptance' of market opinion by holding the indexed (market) portfolio rather than estimating betas or μ_i and $\sigma_{i,j}$ indexing means
  - What to do if you have information that you believe has not yet been incorporated into market prices?
- no security analysis
- no 'market timing'

Strategy 3: Indexing

Prerequisites for approximation of market porfolio by index

- Index uses market value weights (e.g. S&P 500, DAX).
  - If index reflected the market portfolio: Share of stock i in all individual porfolios = market capitalization of stock i : overall capitalization of DAX companies.
- Total value of the stocks in the index is close to the value of all stocks.

Strategy 3: Indexing

DAX 30	Market capitalization as of 08/21/2013 (m €)	
Volkswagen Vz DE0007664039	82429.78	9.22%
Bayer N DE000BAY0017	72366.2	8.09%
Siemens N DE0007236101	72365.34	8.09%
SAP DE0007164600	69373.63	7.76%
BASF N DE000BASF111	62107.53	6.94%
Daimler N DE0007100000	58211.18	6.51%
Allianz N DE0008404005	51681.93	5.78%
BMW DE0005190003	47653.79	5.33%
Deutsche Telekom N DE0005557508	41350.7	4.62%
Deutsche Bank N DE0005140008	33883.07	3.79%
Henkel Vz DE0006048432	30274.36	3.39%
Linde DE0006483001	27089.21	3.03%

Strategy 3: Indexing

DAX 30	Market capitalization as of 08/21/2013 (m €)	
Deutsche Post N DE0005552004	25975.71	2.90%
Muench Rueckvers N DE0008430026	25511.29	2.85%
E.ON N DE000ENAG999	24142.07	2.70%
Continental DE0005439004	23530.7	2.63%
adidas N DE000A1EWWW0	17398.42	1.95%
Beiersdorf DE0005200000	17067.96	1.91%
Fresenius DE0005785604	16972.35	1.90%
Fresenius Med Care DE0005785802	15221.66	1.70%
RWE DE0007037129	12856.67	1.44%
Deutsche Boerse N DE0005810055	10414.28	1.16%
HeidelbergCement DE0006047004	10203.75	1.14%
Commerzbank DE000CBK1001	8985.1	1.00%
ThyssenKrupp DE0007500001	8170.09	0.91%
Merck DE0006599905	7634.99	0.85%
Infineon Technolo N DE0006231004	7418.46	0.83%
Dt.Lufthansa N DE0008232125	6512.85	0.73%
LANXESS DE0005470405	3924.67	0.44%
K+S N DE000KSAG888	3624.16	0.41%
Total	894351.9	100.00%

Strategy 3: Indexing

Problem: Completely diversified funds do not exist

- Mutual funds are classified into equity funds, fixed-income funds, etc.
- Mutual funds are further classified into styles: growth, income, blue-chip, etc.

Strategy 3: Indexing

Problem: Information efficiency

What to do if you have information that you believe has not yet been incorporated into market prices?

Section 5

Empirical failure of CAPM

Empirical failure of CAPM

- Pretty unrealistic assumptions
  - Investors are supposed to have the same information.
  - Unlimited borrowing at risk-less rate.
  - No transaction costs (borrowing and investing at the same rate)
- Pretty unrealistic finding: All investors hold the same porfolio (the market porfolio).
- Identifying and measuring the market return is difficult