Lecture 6
CAPM and Single Index Models

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Recall: Using the Markowitz Model

- To create an optimal portfolio, we need to estimate the variance/efficient frontier, MVE portfolio and the best CAL
- Where are the inputs coming from?

$\hookrightarrow$ For a portfolio of N (100) securities we need:

σ_i's	N	100
$E(r_i)$'s	N	100
$Cov(r_i, r_j)$'s	$\frac{1}{2}N(N-1)$	4950
Total	$\frac{1}{2}N(N+3)$	5150

A Remedy

- Use CAPM to determine what market believes expected returns should be
- Use a single factor model to calculate asset covariances
- Then we can combine our "views" with the CAPM-derived estimates to get portfolio weights

→ The key input we will need for these is the set of asset betas. How to estimate beta?

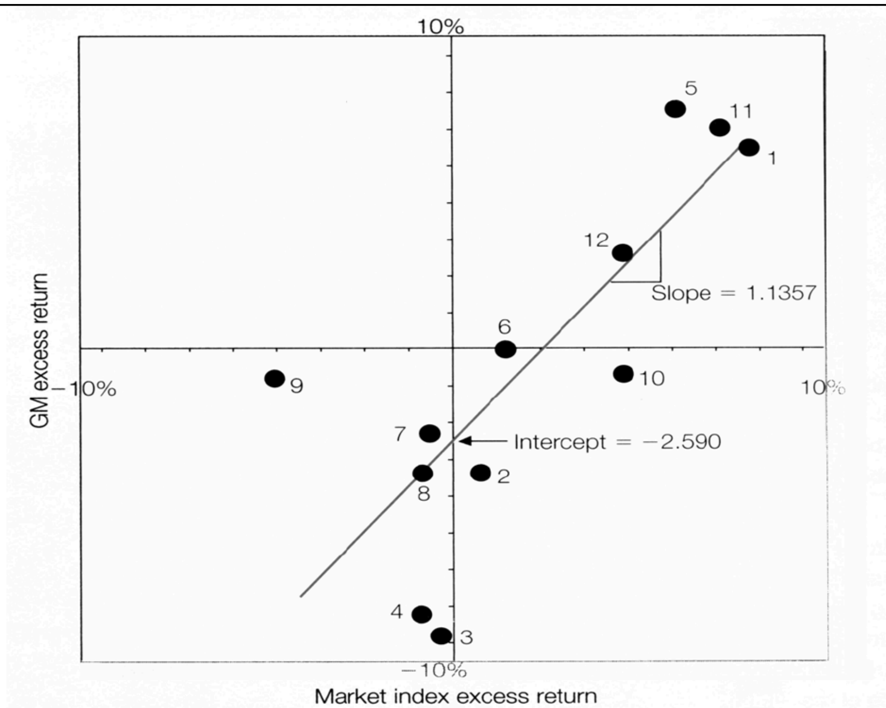
Estimating Beta

- The standard way to estimate a beta is to use a characteristic line equation
- We typically use monthly data
  - Can we use weekly, daily, or intra day data?
- Typically use 5 years of data
  - Why not use more?

Month	GM Return	Market Return	Monthly T-Bill Rate	Excess GM Return	Excess Market Return
January	6.06	7.89	0.65	5.41	7.24
February	−2.86	1.51	0.58	−3.44	0.93
March	−8.18	0.23	0.62	−8.79	−0.38
April	−7.36	−0.29	0.72	−8.08	−1.01
May	7.76	5.58	0.66	7.10	4.92
June	0.52	1.73	0.55	−0.03	1.18
July	−1.74	−0.21	0.62	−2.36	−0.83
August	−3.00	−0.36	0.55	−3.55	−0.91
September	−0.56	−3.58	0.60	−1.16	−4.18
October	−0.37	4.62	0.65	−1.02	3.97
November	6.93	6.85	0.61	6.32	6.25
December	3.08	4.55	0.65	2.43	3.90
Mean	0.02	2.38	0.62	−0.60	1.75
Std Dev	4.97	3.33	0.05	4.97	3.32

Regression Results	$r_{GM} - r_f = \alpha + \beta(r_M - r_f)$	
	α	β
Estimated coefficient	−2.590	1.1357
Standard error of estimate	(1.547)	(0.309)

Variance of residuals = 12.601
Standard deviation of residuals = 3.550
R-SQR = 0.575



- If you use total rather than excess returns

Estimating beta for new companies

- In the absence of historical data, how would we estimate beta for new companies?
- Standard industry practice is to use "comparables"
  - Find a similar company and use their beta
  - If a comparable company can't be found, predict beta from a sample of companies with similar characteristics
- Which characteristics to use?

- Select a sample of companies to estimate the model
- Estimate the beta for these companies using historical return data
- Regress estimated betas on several characteristics that drive betas

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

- We can use rolling window regressions to estimates the betas
  - At month t estimate beta using months t-60 through t-1
  - At month t+1 estimate beta using months t-59 through t
- Alternatively, use more sophisticated statistical models that allow for time-variation in beta

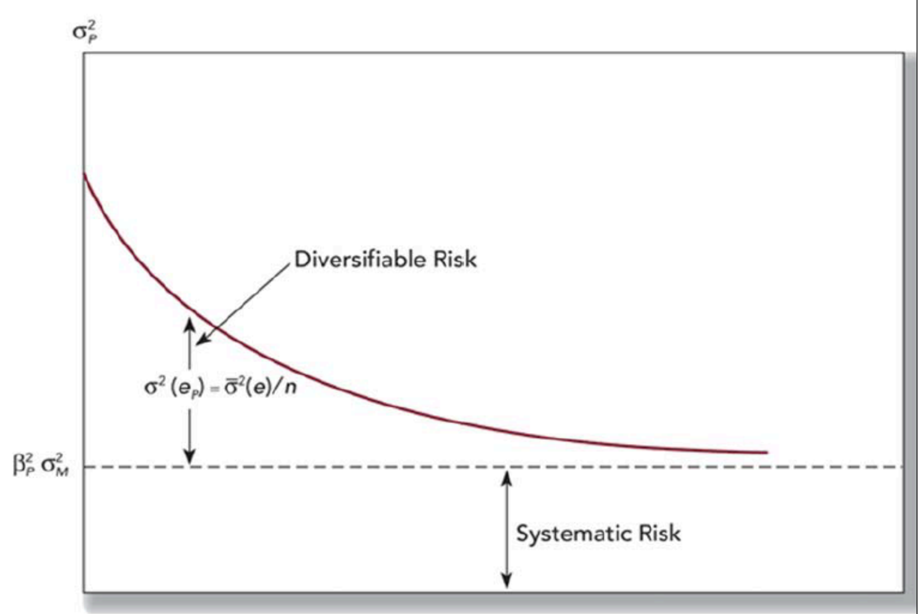
Getting Expected Returns

- To get the market's beliefs about expected returns, use the CAPM
- Remember, this is estimated by the regression

Getting the covariances

- We can estimate the covariances between securities by assuming that a single index model describes the returns

Getting the covariances (cont.)



Note: The Single Index Model vs CAPM

- The single index model is a statistical model
  - It specifies that all common movements between stocks can be captured by a single index (also called the single factor model)
  - Can be generalized to multiple common factors
  - It is a statistical technique designed to estimate large covariance matrices
- The CAPM is an economic model of expected returns
  - It specifies that the market portfolio captures systematic risk
  - However, it does allow securities i and j to be correlated on top of what their covariance with the market portfolio implies, for instance if they are in the same industry. The only requirement is that these correlations "wash out" as we add more stocks.

- Therefore, to construct efficient frontier based on the single index model (for 100) securities, we need estimates of the following

r_f	1	1
$E(r_m)$	1	1
σ_m^2	1	1
α_i	N	100
β_i	N	100
$\sigma_{\varepsilon,i}^2$	N	100
Total	$3N+3$	303

- This is considerably smaller than the 5150 we had before.

- Plug expected returns, return standard deviations, correlation matrix into Excel spreadsheet to get the weights that form the tangency portfolio
- However, there may be times when we think that the market is a little wrong along one or more dimensions
- How can we combine our views with what the market expects?

- What if I think the market has underestimated the earnings that a company will announce next month, eg. the expected return will be 2 percent higher than what market expects

- What if I think its risk (beta) is increasing?

CAPM in Practice

- If the CAPM is true, all securities should lie on the SML
- Testing CAPM:

Tests of CAPM

- First set of results (Lintner, and Miller and Scholes) based on 631 NYSE stocks for 10 years during 1954-1963

Coefficient:	$\gamma_0 = .127$	$\gamma_1 = .042$	$\gamma_2 = .310$
Standard error:	.006	.006	.026
Sample average:		$\overline{r_M - r_f} = .165$	

Some Explanations

- Stock returns are extremely volatile, lessening precision (eg. average standard deviation of annual returns on the stocks in the S&P 500 is 40%)
- The market index is not the "market portfolio" of CAPM (The Roll critique)
- Security betas from the first stage regressions can be estimated with substantial sampling errors
- Investors cannot borrow at the risk free rate

Some Anomalies

1) Size Effect:

Small stocks (low market cap) tend to have higher expected returns than the CAPM prediction and large stocks tend to have lower expected returns than the CAPM prediction

- Beta is inversely related to size

→ Liquidity Risk: Small stocks are more illiquid and may thus command a higher premium

Some Anomalies (cont.)

2) Value effect:

Value stocks (those with high book value-to-market value ratios) tend to have higher expected returns than the CAPM prediction and growth stocks (those with low book-to-market ratios) have lower expected returns than the CAPM prediction

→ Distress risk: Value stocks tend to be stocks that have underperformed in the past. A lot of them are in the verge of bankruptcy and may be particularly risky. Investors require an additional premium in order to hold them

Some Anomalies (cont.)

3) Momentum Effect:

Momentum stocks (those that have done well in the past year) have higher expected returns than the CAPM prediction, and recent loser stocks (those that have done poorly in the past year) have lower expected returns than the CAPM prediction

→ Under-reaction (bad news travels slowly), disposition effect (quickly selling winners to show success, holding on to losers to avoid admitting mistakes i.e. ride losses and realize gains)

Extensions of CAPM

- The market portfolio may not capture all systematic risk
- Use multi-factor models that include other variables such as other economic risks

- Arbitrage Pricing Theory, Intertemporal CAPM

Readings

- Fama and French: “CAPM: Theory and Evidence”
- Jorion “Portfolio Optimization in Practice”

Homework

- Ch 8 # 1, 7, 9-12
- Ch 9 # 3, 8 ,20