Lecture 14: Implementing CAPM

- Question: So, how do I apply the CAPM?

- Current reading:
  – Brealey and Myers, Chapter 9
  – Reader, Chapter 15

Key Results So Far

- All investors should split their money between the **market portfolio** and the risk-free asset.
  - In practice, buy an **index fund**, or an **exchange traded fund.**
- The **Capital Asset Pricing Model**:

$$r_i = r_f + \beta_i \left[E(\tilde{r}_m) - r_f \right],$$

$$\beta_i = \frac{\text{Cov}(\tilde{r}_i, \tilde{r}_m)}{\text{Var}(\tilde{r}_m)}.$$

- Expected return is related to the stock's "beta"
  - Depends on <u>covariance</u> with the market: **Market Risk**
  - Does <u>not</u> depend on its variance: **Firm Specific Risk**
  - Remember our diversification example…

Expected Return and Beta 1

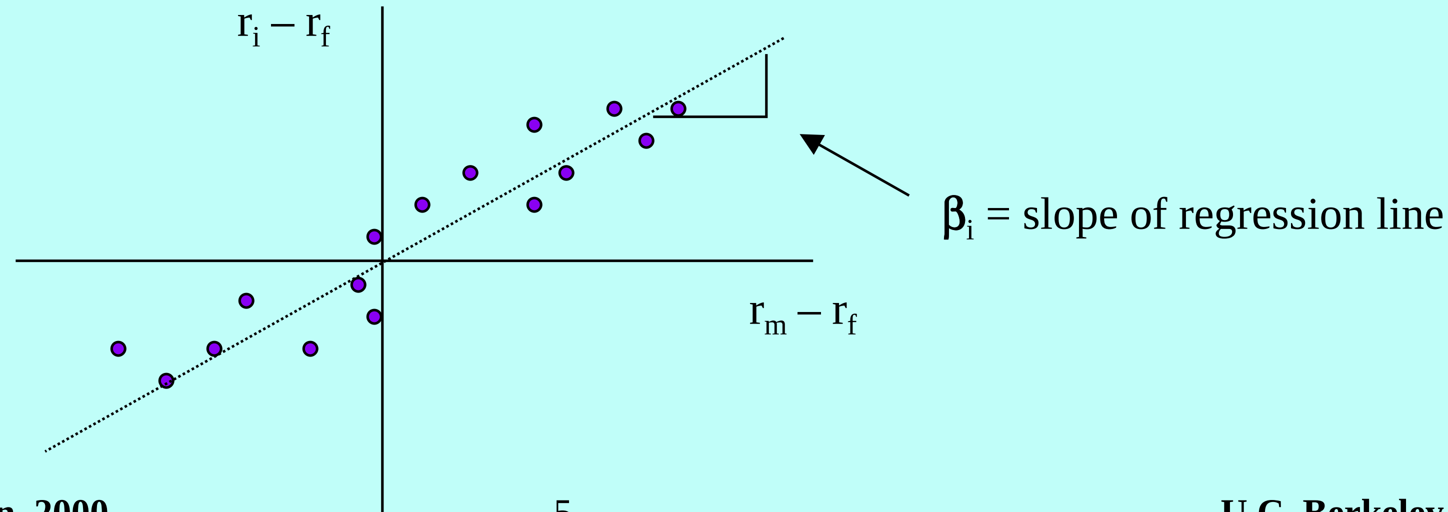
- What is the expected return on a stock with $\beta = 0$?
  - Answer is r_f: Same return as risk-free asset!
- Why?
  - Think about insuring lots of houses against fire.
  - Each individually is risky, but
  - When you diversify by insuring lots of houses, overall portfolio becomes riskless.

Expected Return and Beta 2

- What is the expected return on a stock with $\beta < 0$?
- If $\beta < 0$, then $r_i < r_f$! You'd accept a return lower than the risk-free rate?
- Why?
  - It pays off most when you most need the money.
    - » All your other investments have gone down in value
  - This stock provides you with **insurance**
  - It is more valuable than a risk-free payoff.

Interpreting/Estimating β

- β is defined by $\beta_i = \frac{\mathrm{Cov}(\tilde{r}_i, \tilde{r}_m)}{\mathrm{Var}(\tilde{r}_m)}$.
- Does this look familiar?
- It's the slope we get when we **regress** $\tilde{r}_i$ on $\tilde{r}_m$.
  - In practice, regress **excess returns**, $(\tilde{r}_i - r_f)$ on $(\tilde{r}_m - r_f)$.



Estimating Beta

- So to estimate the beta of a particular stock,
  - Regress (excess) returns on the stock against (excess) returns on the "market portfolio" (e.g. S&P 500 index).
  - The slope of the regression line is your estimate of beta.
  - Do the same for other firms in same industry to reduce uncertainty
- Now plug the estimate into the formula:

$$r_i = r_f + \beta_i(r_m - r_f).$$

Where to get data?

- Where to get the data to estimate the β of, say, IBM?
- One easy to use (and free) source is Yahoo! Finance:
  - IBM (IBM): http://finance.yahoo.com/q?s=ibm&d=b
  - S&P 500 (^SPX): http://finance.yahoo.com/q?s=^SPX&d=b
  - 3m T-Bill (^IRX): http://finance.yahoo.com/q?s=^IRX&d=b
- You can also download data from **Datastream**, available in the library.

Importing data into Excel

- Yahoo’s Web site allows you to download data as a spreadsheet manually.
- Excel (at least 97 on) allows you to download data from Web sites automatically using “Get External Data” (under the “Tools” menu).

What risk free rate to use?

- In the regression, if using (say) monthly returns, you need a monthly risk-free rate.
- The 3m T-Bill rate is a good number to start with.
  - Shorter maturity T-Bills are rather volatile.
- **Important**: You need to convert the quoted number to a monthly rate correctly:
  - Yahoo quotes the rate as a **discount**
  - Datastream quotes the rate like the **ask yield** in the WSJ

Example - Estimating IBM beta (data from Yahoo)

Yahoo quotes discount

Convert to monthly r_f

	Price			Monthly Return			Excess Return	
Date	**IBM**	**S&P**	**3m T-Bill**	**IBM**	**S&P**	**3m T-Bill**	**IBM**	**S&P**
9/1/00	112.625	1436.51	6.03	-14.6881%	-5.3483%	0.5144%	-15.2025%	-5.8627%
8/1/00	132.0156	1517.68	6.11	17.7397%	6.0699%	0.5068%	17.2329%	5.5631%
7/1/00	112.125	1430.83	6.02	2.4534%	-1.6341%	0.4796%	1.9738%	-2.1137%
6/1/00	109.44	1454.6	5.7	2.0962%	2.3934%	0.4617%	1.6345%	1.9316%
5/1/00	107.193	1420.6	5.49	-3.7549%	-2.1915%	0.4753%	-4.2302%	-2.6668%
4/1/00	111.375	1452.43	5.65	-5.8084%	-3.0796%	0.4813%	-6.2896%	-3.5608%
...								
3/1/99	88.5254	1286.37	4.36	4.4182%	3.8794%	0.3821%	4.0361%	3.4974%
2/1/99	84.7797	1238.33	4.55	-7.3669%	-3.2283%	0.3660%	-7.7329%	-3.5942%
1/1/99	91.522	1279.64	4.36	-0.6101%	4.1009%	0.3652%	-0.9752%	3.7358%
12/1/98	92.0838	1229.23	4.35	11.6579%	5.6375%	0.3711%	11.2868%	5.2665%
11/1/98	82.4696	1163.63	4.42	11.1954%	5.9126%	0.3533%	10.8421%	5.5593%
10/1/98	74.1664	1098.67	4.21	15.5643%	8.0294%	0.3567%	15.2076%	7.6727%

- Now regress IBM excess return against S&P excess return.

Converting quoted rates to true r_f: Yahoo

- Slight simplification: Assume ¼ year to maturity.
- Yahoo quotes a **discount** of 6.11% on 8/1/00
  – Price = 100 x (1 – 6.11% x 90/360) = $98.4725
  – 3 month rate = (100/98.4725) – 1 = 1.551%
  – One month $r_f = 1.01551^{1/3} - 1 = 0.514\%$
- **Note**: this is r_f for the month ending **9**/1/00

Converting quoted rates to true r_f: Datastream

- Datastream quotes a **yield** of 6.25% on 8/1/00.
  - 3 month rate = 6.25% / 4 = 1.5625%
  - One month $r_f = 1.015625^{1/3} - 1 = 0.518\%$
- Note: this is r_f for the month ending **9**/1/00.
- This is not identical to the result we calculated from Yahoo, but it's close.
  - Numbers only quoted to 2 significant figures.
  - May use different data sources.

Running the Regression

- To perform regression, use Excel's regression tool
  - Tools -> Data Analysis -> Regression
  - Need to install **Analysis Toolpack** addin first.
  - Do not fix intercept to be zero.
  - Can also use built in SLOPE() command.
- From 2 yrs monthly data, IBM vs S&P, we get:

	Coefficients	*Standard Error*		
Intercept	0.010276442	0.0176991		
S&P	1.240872289	0.385268035		

Estimate of β

Interpreting R^2

- The regression also reports an R^2 value
  - 0.32 in our example. What does it tell us?
- The regression can be written as

$$\tilde{r}_i - r_f = \beta_i(\tilde{r}_m - r_f) + \tilde{\varepsilon}.$$

So
$$\mathrm{var}(\tilde{r}_i - r_f) = \beta_i^2\,\mathrm{var}(\tilde{r}_m - r_f) + \mathrm{var}(\tilde{\varepsilon}).$$

Total risk = Market risk + Firm-specific risk

- R^2 is defined as:

$$R^2 = \frac{\beta_i^2\,\mathrm{var}(\tilde{r}_m - r_f)}{\mathrm{var}(\tilde{r}_i - r_f)} = \frac{\text{Market risk}}{\text{Total risk}} = \frac{\text{Market risk}}{\text{Market risk} + \text{Firm - specific risk}}.$$