Session #3: CAPM & Beta
Damodaran Chpt 6: 2,6,8,12,16,20

I. Applications of CAPM

1) risk premium

	Stock-TBill		Stock-TBond	
	Arithmetic Mean	Geometric Mean	Arithmetic Mean	Geometric Mean
1926-90	8.41%	6.41%	7.25%	5.5%*
1926-88	8.5%*			

2) risk free rate

Tbill vs. Tbond, consistent with risk premium

Using CAPM to get Expected Returns.

Risk free rate (R_f)	Risk Premium ($E(R_m)-R_f$)
Short-term Government Security Rate (T-Bill)	**Historical premium earned by stocks over short term rates (arithmetic mean)** ***$E(R_{jj})$ = ST Govt rate + Beta * (Historical premium over short term govt security rates)***
Long-term Government Security Rate (T-Bond)	**Historical premium earned by stocks over long term rates (geometric mean)** ***$E(R_{jj})$ = long term rate + Beta * (Historical premium over long term rates)***

Example: Continental Airlines

Beta = 1.5
6 mo. Tbill = 5.24%
Risk premium = 8.5%
Expected return from CAPM = 17.99%

Or

Beta = 1.5
20 year Treasury bond = 7%
Risk premium = 5.5%
Expected return from CAPM = 15.25%

Using the CAPM: Continental Airlines

In Prediction

1. **Get current risk free rate:**
   6 Mo. T-Bill = 5.24%
2. **Get beta for project you want to predict expected return for:**
   Beta (from Bloomberg) = 1.50
3. **Use historical premium of stocks over Tbills as measure of market risk premium:**
   Historical premium ($E(R_m)-R_f$) = 8.5%
4. **Estimate expected return:**
   $E(R_j)= R_f + \beta_j(E(R_m)- R_f) =$ 5.24% + 1.50*8.5% = 17.99%

Current stock price = 22 3/8
Expected dividend = $0
Expected price in one year = 22.375*(1.1799) = $26.40

In Evaluation

1. **Get risk free rate from start of period of evaluation:**
   6 mo. T-Bill 1 year ago = 5.30
2. **Get beta for project you want to evaluate:**
   Beta = 1.50
3. **Get actual return on market index for period of evaluation:**
   S&P 500: 1 year ago = 584.41 ;
   today = 687.31 ; return on market = 17.6%
4. **Estimate return you would have expected during period of evaluation:**
   Expected return = 5.30 + 1.50*(17.6-5.3) =23.75%
5. **Estimate actual returns:**
   Actual returns = (22.375 - 17.8125)/17.8125 = 25.61%
6. **Compare actual to expected return:**
   Excess return = actual - expected = 1.86%

II. Measuring Betas.

Basic Methodology:
The basic approach is to run a regression of returns on the stock on returns on the market,

$$R_{it} = a_i + b_i R_{mt} + e_{it}$$

where

R_{it} = returns on stock i in interval t (t=1,…,T)
R_{mt} = returns on market index in interval t
a_i = intercept from regression (alpha)
b_i = estimate of beta
e_{it} = error term in the regression

Calculating returns:

$$\text{stock return} = (P_t - P_{t-1} + \text{Div})/P_{t-1}$$

(returns must be split adjusted)

$$\text{market return} = (\text{Index}_t - \text{Index}_{t-1})/\text{Index}_{t-1} + \text{Dividend yield}$$

Key output from the regressions:

1. Intercept (constant): from the CAPM:

$$R_j = R_f + \beta(R_m - R_f)$$

Rearranging terms,

$$R_j = R_f (1-\beta) + \beta R_m$$

If the CAPM holds, the intercept in the regression should be equal to $R_f(1-\beta)$

To evaluate how well a company has performed relative to expectations,

if $a_j > R_f (1-\beta)$ The company did better than expected during the period of the regression

if $a_j < R_f (1-\beta)$ The company did worse than expected during the period of the regression

$a_j - R_f (1-\beta)$ = Jensen's alpha

2. Slope (beta): This is an estimate of the beta of the firm which can then be used in the CAPM.

3. Variance of the stock (σ_i^2): This is the total return variance of the stock over the time period for which you have historical returns (If you use daily (weekly, monthly) returns this will be a daily (weekly, monthly) variance and can be annualized by multiplying by 365 (52,12).

4. Variance of the market index (σ_m^2): This is the total return variance of the market index that you use in the regression.

5. Systematic variance ($=\beta^2\sigma_m^2$): This is the portion of the total variance of the stock returns that is due to market movements (and hence cannot be diversified).

6. Unsystematic variance ($= \sigma_i^2 - \beta^2\sigma_m^2$): This is the portion of the total variance of the stock returns that is firm-specific and can be diversified away.

R^2 ($= \beta^2\sigma_m^2/\sigma_i^2$): This is the proportion of the total variance of the stock that is due to market movements. A high (low) R squared indicates that a small (large) proportion of the firm's total risk is due to firm-specific risk.

EXAMPLE: MCDONNELL DOUGLAS CORP

	Month	Stock price	Stock DPS	Split factor	S&P500 Index level	Stock return	Market return	$(R_{jt} - R_j)^2$	$(R_{mt} - R_m)^2$	$(Rjt - Rj)^*$ $(R_{mt} - R_m)$
1.	Sep-96	52.625		1	687.33	5.0%	5.4%	0.00030	0.00196	0.00076
2.	Aug-96	50.125		1	651.99	12.0%	1.9%	0.00764	0.00008	0.00077
3.	Jul-96	44.750	0.12	1	639.95	-8.0%	-4.6%	0.01261	0.00310	0.00625
4.	Jun-96	48.750		1	670.63	-3.5%	0.2%	0.00454	0.00006	0.00052
5.	May-96	50.500		2	669.12	4.7%	2.3%	0.00019	0.00017	0.00018
6.	Apr-96	48.250	0.12	2	654.17	5.6%	1.3%	0.00054	0.00001	0.00008
7.	Mar-96	45.813		2	645.50	3.8%	0.8%	0.00003	0.00000	-0.00001
8.	Feb-96	44.125		2	640.43	-0.8%	0.7%	0.00169	0.00001	0.00012
9.	Jan-96	44.500	0.12	2	636.02	-3.0%	3.3%	0.00393	0.00051	-0.00142
10.	Dec-95	46.000		2	615.93	3.2%	1.7%	0.00000	0.00006	0.00000
11.	Nov-95	44.563		2	605.37	9.0%	4.1%	0.00331	0.00097	0.00179
12.	Oct-95	40.875	0.10	2	581.50	-1.0%	-0.5%	0.00179	0.00022	0.00063
13.	Sep-95	41.375		2	584.41	3.1%	4.0%	0.00000	0.00091	-0.00005
14.	Aug-95	40.125		2	561.88	-2.9%	0.0%	0.00377	0.00011	0.00063
15.	Jul-95	41.313	0.10	2	562.06	7.9%	3.2%	0.00216	0.00048	0.00101
16.	Jun-95	38.375		2	544.75	6.2%	2.1%	0.00088	0.00013	0.00034
17.	May-95	36.125		2	533.40	16.5%	3.6%	0.01759	0.00069	0.00350
18.	Apr-95	31.000	0.10	2	514.71	11.6%	2.8%	0.00689	0.00032	0.00149
19.	Mar-95	27.875		2	500.71	-0.4%	2.7%	0.00138	0.00030	-0.00065
20.	Feb-95	28.000		2	487.39	12.0%	3.6%	0.00762	0.00068	0.00228
21.	Jan-95	25.000	0.10	6	470.42	6.0%	2.4%	0.00076	0.00021	0.00040
22.	Dec-94	23.672		6	459.27	1.8%	1.2%	0.00021	0.00001	-0.00003
23.	Nov-94	23.250		6	453.69	-1.1%	-4.0%	0.00188	0.00245	0.00214
24.	Oct-94	23.500	0.10	6	472.35	22.6%	2.1%	0.03736	0.00012	0.00210
25.	Sep-94	19.250		6	462.71	-2.3%	-2.7%	0.00310	0.00136	0.00205
26.	Aug-94	19.703		6	475.50	4.6%	3.8%	0.00019	0.00077	0.00038
27.	Jul-94	18.828	0.06	6	458.26	-3.1%	3.1%	0.00412	0.00046	-0.00138
28.	Jun-94	19.500		6	444.27	-2.8%	-2.7%	0.00369	0.00135	0.00223
29.	May-94	20.063		6	456.51	2.5%	1.2%	0.00006	0.00001	-0.00002
30.	Apr-94	19.578	0.06	6	450.91	9.5%	1.2%	0.00385	0.00000	0.00010
31.	Mar-94	17.938		6	445.76	-9.7%	-4.6%	0.01695	0.00310	0.00725
32.	Feb-94	19.875		6	467.14	4.3%	-3.0%	0.00012	0.00160	-0.00043
33.	Jan-94	19.047	0.06	6	481.61	7.2%	3.3%	0.00152	0.00051	0.00088
34.	Dec-93	17.828		6	466.45	-2.0%	1.0%	0.00275	0.00000	-0.00001
35.	Nov-93	18.188		6	461.79	16.4%	-1.3%	0.01724	0.00052	-0.00300
36.	Oct-93	15.625	0.06	6	467.83	4.4%	1.9%	0.00014	0.00009	0.00011
37.	Sep-93	15.016		6	458.93	11.2%	-1.0%	0.00633	0.00040	-0.00159
38.	Aug-93	13.500		6	463.56	-6.1%	3.4%	0.00875	0.00060	-0.00229
39.	Jul-93	14.375	0.06	6	448.13	16.8%	-0.5%	0.01825	0.00023	-0.00206
40.	Jun-93	12.359		6	450.53	12.4%	0.1%	0.00826	0.00008	-0.00084
41.	May-93	11.000		6	450.19	9.5%	2.3%	0.00387	0.00016	0.00079
42.	Apr-93	10.047	0.06	6	440.19	6.9%	-2.5%	0.00132	0.00125	-0.00128
43.	Mar-93	9.453		6	451.67	7.5%	1.9%	0.00176	0.00008	0.00037
44.	Feb-93	8.797		6	443.38	-9.6%	1.0%	0.01664	0.00000	-0.00007
45.	Jan-93	9.734	0.06	6	438.78	21.7%	0.7%	0.03395	0.00001	-0.00054
46.	Dec-92	8.047		6	435.71	4.5%	1.0%	0.00014	0.00000	0.00000
47.	Nov-92	7.703		6	431.35	-9.5%	3.0%	0.01641	0.00041	-0.00260
48.	Oct-92	8.516	0.06	6	418.68	36.8%	0.2%	0.11270	0.00006	-0.00263
49.	Sep-92	6.266		6	417.80	-7.8%	0.9%	0.01229	0.00000	0.00009
50.	Aug-92	6.797		6	414.03	11.0%	-2.4%	0.00593	0.00115	-0.00262
51.	Jul-92	6.125	0.06	6	424.22	-4.9%	3.9%	0.00663	0.00087	-0.00240
52.	Jun-92	6.500		6	408.14	-9.0%	-1.7%	0.01498	0.00075	0.00334
53.	May-92	7.141		6	415.35	-24.5%	0.1%	0.07691	0.00008	0.00249
54.	Apr-92	9.453	0.06	6	414.95	-4.7%	2.8%	0.00641	0.00032	-0.00144
55.	Mar-92	9.984		6	403.69	-5.6%	-2.2%	0.00789	0.00101	0.00282
56.	Feb-92	10.578		6	412.70	-6.9%	1.0%	0.01030	0.00000	0.00004
57.	Jan-92	11.359	0.06	6	408.78	-6.4%	-2.0%	0.00942	0.00089	0.00290
58.	Dec-91	12.203		6	417.09	4.3%	11.2%	0.00010	0.01033	0.00102
59.	Nov-91	11.703		6	375.22	-0.3%	-4.4%	0.00125	0.00290	0.00190
60.	Oct-91	11.734	0.06	6	392.45	9.5%	1.2%	0.00393	0.00000	0.00012
61.	Sep-91	10.766		6	387.86					

	3.3%	1.0%	0.00925	0.00075	0.00044
	=Ave(R_j)	=Ave(R_m)	=Var(R_j)	=Var(R_m)	=Cov(R_J,R_M)

* DPS = Dividends per share
** Stock prices and dividends are split adjusted: 2:1 split 5/96, 3:1 split 1/95

Current 6 mo T-Bill:	5.24%
Ave 6 mo. T-Bill during estimation period:	4.37%

Regression Statistics and Risk Parameters

Intercept [= alpha]	0.0268	Average stock return - beta*average market return
Slope [= beta]	0.5912	This is the beta of the stock = cov(R_j,R_m)/var(R_m)
R_f(1-beta)	1.79%	Average T-Bill rate during regression period * (1-beta)
Intercept - R_f(1-beta)	0.89%	Measure of performance (.89% better than expected per month!)

Variance Statistics

Variance of Stock	0.00925	
Variance of Market	0.00075	
Systematic variance	0.00026	Portion of MD variance explained by the market = beta^2*(variance of market)
Unsystematic variance	0.00899	Diversifiable risk = Total variance - systematic variance
R^2	0.02827	Systematic variance/Total variance

Using beta to estimate expected returns

6 mo. T-Bill	5.24%	current risk free rate
Historical return premium	8.50%	based on historical data
Expected return	10.27%	risk free rate + beta*premium

Using beta to forecast prices

Current price	52.625	
Annualized DPS	0.48	
Predicted prices:		
One year from now	57.547	Current price*(1 + expected return - dividend yield)
Two years from now	62.929	Current price*(1 + expected return - dividend yield)^2
Three years from now	68.815	Current price*(1 + expected return - dividend yield)^3
Four years from now	75.252	Current price*(1 + expected return - dividend yield)^4
Five years from now	82.290	Current price*(1 + expected return - dividend yield)^5

Estimating beta.

How much historical data should we use?

How does non-trading effect measured betas?

What return interval should we use?

What data source should we use?

Determinants of beta.

Industry effects:

cyclicality of demand for firm's products
degree of operating leverage

Dividend policy:

Large dividends payments will lower a firm's beta

***Financial leverage effects:**

Using a debt beta = 0, the beta of equity alone can be written as a function of the unlevered beta and the debt-equity ratio:

$\beta_L = \beta_U(1+((1-t)D/E)$ **, where**

β_L **= levered beta (also called** β_E**, equity beta)**
β_U **= unlevered beta (also called** β_A**, asset beta)**
t = corporate marginal tax rate
D,E = market value of debt, equity

*** if debt beta is > 0,** $\beta_L = \beta_U(1+((1-t)D/E) - \beta_D D/E$ **: assume debt beta = 0 unless we specify otherwise.**

Example: McDonnell Douglas equity betas at different levels of leverage.

Current equity (levered) beta 0.59
D/E .875%
current tax rate 34%
market premium = 8.5%
current T-Bill rate = 5.24%

Unlevered beta = current beta/(1 + (1-tax rate)(D/E)
= .59/(1+(1-.34)(.875) = .374

Levered beta at different levels of debt can be estimated:
Levered beta = unlevered beta*(1+(1-tax rate)(D/E)

D/(D+E)	D/E	Levered beta	Cost of equity (%)
0	0.00	0.37	8.42
0.1	0.11	0.40	8.65
0.2	0.25	0.44	8.94
0.3	0.43	0.48	9.32
0.4	0.67	0.54	9.82
0.5	1.00	0.62	10.52
0.6	1.50	0.74	11.57
0.7	2.33	0.95	13.31
0.8	4.00	1.36	16.81
0.9	9.00	2.60	27.30

The unlevered beta (asset beta) for a multi-divisional firm is the weighted average of the unlevered betas for the divisions, where the weights are the relative market values.

Estimating betas using betas of comparable companies:

Example: Continental Airlines, 1992 restructuring

	D/(D+E) [1]	D/E	Equity beta
American Airlines	0.598	1.49	1.45
Delta Air Lines	0.380	0.61	1.10
United Airlines	0.430	0.75	1.25
USAir Group	0.740	2.85	1.65
Average	0.537	1.16	1.36

Unlevered beta of comparable companies = asset beta for Continental =

1.36/(1+(1-.34)(1.16)) = 0.77

[1] **Measured as (Long term debt + capital leases)/total capitalization**

III. Cost of capital

The discount rate depends on the riskiness of the cash flows from assets.

The cost of capital is an opportunity cost -- it depends on where the money goes, not where it comes from.

I. Estimating the cost of equity:

a. The dividend growth model approach

$$R_E = D_1/P_0 + g$$

We can observe P_0 and D_0. $D_1 = D_0(1+g)$. We need to estimate g, either using historical data or an analyst's forecast.

b. The SML approach

$$R_E = R_f + ß_E \times [R_M - R_f]$$

II. The cost of debt: Cost of debt, R_D, is the interest rate on new borrowing. Historic debt cost is irrelevant.

a. Yield on currently outstanding debt.
b. Yields on newly-issued similarly-rated bonds.

III. The cost of preferred stock

Valuing preferred stock as a perpetuity, the cost is

$$R_P = D/P_0$$

(i.e. the dividend yield)

Weighted average cost of capital (WACC)

E = the market value of the equity (# shares x price/sh)
D = the market value of the debt (price of bond x # bonds)
(may be same as book value for short term debt)

$$V = E + D + P$$
$$1 = E/V + D/V + P/V = 100\%$$

The firm's capital structure weights are E/V, D/V and P/V

The weighted average cost of capital is calculated as:

$$WACC = (E/V) \times R_E + (D/V) \times R_D \times (1 - T_C) + (P/V)R_P$$

where $R_D \times (1 - T_C)$ = aftertax cost of debt

Hills Stores has 1 millions shares of common stock outstanding with a market price of $12 per share. The firm's outstanding bonds have ten years to maturity, a face value of $5 million, a coupon rate of 10%, and sell for $985 per $1000 in face value. The risk-free rate is 5.5%, and the expected return on the market is 14%. Hills stock has a beta of 1.2, and Hills is in the 34% tax bracket.

Capital structure weights:

E = MV of equity = 1mm shares x $12/share = $12,000,000
D = MV of debt = $5mm x .985 = $4,925,000

V = E + D = $12,000,000 + 4,925,000 = $16,925,000

D/V = .29 or 29%
E/V = 1-.29 = .71 or 71%

Cost of equity (SML approach):

R_E = .055 + 1.2 x (.14 - .055) = 15.7 %

Cost of debt:

Coupon rate = 10%
P_B = 985
F = 1000
10 years to maturity
find ytm (r)

YTM = 10.25%

WACC:

WACC = (E/V) x R_E + (D/V) x R_D x (1 - T_C)
= (.71 x .) + (.29 x .1025 x .66)
= .1311 = 13.11%