Lectures 13-14: Asset Pricing Model Evidence and Market Efficiency

I. Reading.
   A. BKM, Chapter 13, Sections 13.1-13.3.
   B. BKM, Chapter 12. Read Sections 12.1 and 12.2 but only skim Sections 12.3 and 12.4.

II. Time series vs cross sectional regression.
   1. A time series regression is run using a time series of observations for one stock or portfolio; for example, the Bloomberg Beta estimates are obtained from a time series regression.
   2. A cross sectional regression is run across stocks or portfolios for a given time period.

III. Relation between CAPM and the Market Model.
   A. Market Model: Can always run the following time series regression for a given asset i:

$$r_i(t) = \alpha_{i,M} + \beta_{i,M}\, r_M(t) + e_{i,M}(t).$$

where

$r_i(t) = R_i(t) - R_f$.

$\beta_{i,M} = \text{cov}\,[r_i(t), r_M(t)]/\text{var}\,[r_M(t)] = \text{cov}\,[R_i(t), R_M(t)]/\text{var}\,[R_M(t)]$.

   B. Implications of CAPM for the Market Model
      1. CAPM Restriction : SML:

$$E[R_i] = R_f + \beta_{i,M}\,\{E[R_M] - R_f\}.$$

      2. Taking expectations of the market model regression.

$$E[r_i] = \alpha_{i,M} + \beta_{i,M}\, E[r_M].$$

      3. Rearranging SML gives

$$E[r_i] = 0 + \beta_{i,M}\, E[r_M].$$

      4. CAPM says all assets lie on the SML.
      5. Thus CAPM constrains $\alpha_{i,M} = 0$ for all i.
      6. Can use $\alpha_{i,M}$ to measure performance of a mutual fund.

IV. Evidence: CAPM vs Multifactor Models.

A. Can the ICAPM explain the small-firm effect?

1. Using Historical Data 1/27-12/95.
   a. Use S&P to proxy for the market portfolio.
   b. R_f = 0.30% per month.
2. Small Firm Effect restated.
   a. $E[R_{Small}]$ = 1.37% per month.
   b. $E[R_{S\&P}]$ = 1.00% per month.
   c. $E[R_{Small}] > E[R_{S\&P}]$.
3. But the small firm portfolio does not lie on the SML.
4. What about ICAPM in which investors care about {E[R(t)], σ[R(t)], σ[R(t), DP(end t)]}?
   a. All assets lie on

$$E[R_i] = R_f + \beta_{i,M}\,\lambda_M + \beta_{i,DP}\,\lambda_{DP}$$

where:
λ_M, λ_{DP} are constants that are the same for all assets.
$\beta_{i,DP} = cov[R_i(t), DP(end\ t)]/var[DP(end\ t)]$; so $\beta_{i,M}$ and $\beta_{i,DP}$ are regression coefficients from univariate regressions of $R_i(t)$ on $R_M(t)$ and of $R_i(t)$ on DP(end t).
(1) $\beta_{S\&P,S\&P} = 1$; $\beta_{S\&P,DP} = 0.339$.
(2) $\beta_{Small,S\&P} = 1.297$; $\beta_{Small,DP} = 0.565$.
(3) Implies $\lambda_{S\&P} = 0.256$ and $\lambda_{DP} = 1.297$ since then

S&P: $R_f + \beta_{S\&P,S\&P}\,\lambda_{S\&P} + \beta_{S\&P,DP}\,\lambda_{DP}$ = 0.30 + 1 x 0.256 + 0.339 x 1.297 = 1.00.
Small: $R_f + \beta_{Small,S\&P}\,\lambda_{S\&P} + \beta_{Small,DP}\,\lambda_{DP}$ = 0.30 + 1.297 x 0.256 + 0.565 x 1.297 = 1.37.

   b. All assets also lie on

$$E[R_i] = R_f + \beta^*_{i,M}\,\lambda^*_M + \beta^*_{i,DP}\,\lambda^*_{DP}$$

where:
λ^*_M, λ^*_{DP} are constants that are the same for all assets
$\beta^*_{i,M}$ and $\beta^*_{i,DP}$ are regression coefficients from a multivariate regression of $R_i(t)$ on $R_M(t)$ and DP(end t).
(1) $\beta^*_{S\&P,S\&P} = 1$; $\beta^*_{S\&P,DP} = 0$.
(2) $\beta^*_{Small,S\&P} = 1.294$; $\beta^*_{Small,DP} = 0.127$.
(3) Implies $\lambda^*_{S\&P} = 0.70 = E[R_{S\&P}] - R_f$ and $\lambda^*_{DP} = 1.302$ since then

S&P: $R_f + \beta^*_{S\&P,S\&P}\,\lambda^*_{S\&P} + \beta^*_{S\&P,DP}\,\lambda^*_{DP}$ = 0.30 + 1 x 0.70 + 0 x 1.302 = 1.00.
Small: $R_f + \beta^*_{Small,S\&P}\,\lambda^*_{S\&P} + \beta^*_{Small,DP}\,\lambda^*_{DP}$ = 0.30 + 1.294 x 0.70 + 0.127 x 1.302 = 1.37.

5. So the ICAPM in which investors care about {E[R(t)], σ[R(t)],

$\sigma[R(t), DP(\text{end } t)]\}$ can explain the high expected return on the small firm portfolio relative to the S&P 500 portfolio.

6. What about explaining expected return on a third asset?
   a. Long-term government bond portfolio.
   b. $E[R_{Govt}] = 0.44\%$.
   c. Using univariate Beta equation:
      (1) $\beta_{Govt,S\&P} = 0.070$; $\beta_{Govt,DP} = 0.044$.
      (2) So

Govt: $R_f + \beta_{Govt,S\&P}\, \lambda_{S\&P} + \beta_{Govt,DP}\, \lambda_{DP} = 0.30 + 0.070 \text{ x } 0.256 + 0.044 \text{ x } 1.297 = 0.37 < 0.44$.

7. So the ICAPM in which investors care about $\{E[R(t)], \sigma[R(t)], \sigma[R(t), DP(\text{end } t)]\}$ can not explain expected returns on stocks and bonds.
8. Researchers typically use additional (alternative) state variables.

B. Risk Loading Proxies: Size and Book to Market.

1. Fama and French [1992].
2. 100 portfolios: within each size decile form 10 portfolios on the basis of Beta with respect to the market.
3. Each month t run the following cross-sectional regression:

$$R_i = \gamma_{o,t} + \gamma_{1,t}\,\beta_{i,M} + \gamma_{2,t}\,\ln(ME_i) + \gamma_{3,t}\,\ln(BE/ME_i) + u_i$$

where

R_i is the return on stock i in month t.
$\beta_{i,M}$ is the Beta with respect to the market for stock i in month t (estimated running a time series regression of asset return on market return).
$\ln(ME_i)$ is the log of the market value of stock i as of the end of most recent June relative to month t.
$\ln(BE/ME_i)$ is the log of book equity over market value of stock i with market value as of the most recent June and book equity as of the calendar year end just prior to that June.

4. CAPM Implications.
   a. Take expectations of cross sectional regression:

$$E[R_i] = E[\gamma_o] + E[\gamma_1]\,\beta_{i,M} + E[\gamma_2]\,\ln(ME_i) + E[\gamma_3]\,\ln(BE/ME_i)$$

   b. CAPM says:
      (1) $E[\gamma_o] = R_f$.
      (2) $E[\gamma_1] = E[R_M] - R_f > 0$.
      (3) $E[\gamma_2] = 0$ and $E[\gamma_3] = 0$.
5. Results.
   a. Average return varies inversely with size but hardly varies with Beta (see p 21); inconsistent with CAPM.
   b. Find for the cross sectional regressions:
      (1) average γ_1 is not significantly different from 0.
      (2) average γ_2 is significantly negative and average γ_3 is significantly positive.
   c. Results imply market proxy is not on the MVF for the individual stocks.
6. ICAPM context:
   a. Interpret $\ln(ME_i)$ and $\ln(BE/ME_i)$ as proxying for risk loadings ($\beta_{i,sk}$ s) on state variables that individuals care about.
   b. Interpret $E[\gamma_2]$ and $E[\gamma_3]$ as proxying for risk premiums (λ_{sk} s).

C. Limitations of CAPM Tests.
   1. Tests always use some kind of proxy for the market portfolio.
      a. Market Portfolio is the value weighted portfolio of all assets which is unobservable (Roll [1977]'s critique).
   2. Tests only use a subset of all available assets.
      a. If the CAPM holds, every asset lies on the SML but not every asset is used in testing.

D. Candidate State Variables in ICAPM: The Fama and French 3-Factor Model.

1. Fama and French [1993].
2. 25 portfolios:
   a. quintile break-points calculated on the basis of size and book-to-market.
   b. form 25 value-weighted portfolios based on these breakpoints.
3. Two state variables:
   a. SMB zero-investment portfolio: long small and short big stocks, while being book-to-market neutral.
   b. HML zero-investment portfolio: long high and short low book-to-market stocks, while being size neutral.
4. For each portfolio *i*, run the following multi-variate <u>time-series</u> regression:

$$r_i(t) = \alpha_{i,3} + \beta^*_{i,M}\ r_M(t) + \beta^*_{i,SMB}\ r_{SMB}(t) + \beta^*_{i,HML}\ r_{HML}(t) + u_i(t)$$

where

$r_i(t)$ is the excess return on portfolio i in month t.
$r_M(t)$ is the excess return on market portfolio in month t.
$r_{SMB}(t)$ is the return on the SML portfolio in month t.
$r_{HML}(t)$ is the return on the HML portfolio in month t.
$\alpha_{i,3}$, $\beta^*_{i,M}$, $\beta^*_{i,SMB}$, and $\beta^*_{i,HML}$ are the regression coefficients.

5. ICAPM Implications.
   a. Take $r_{SMB}(t)$ and $r_{HML}(t)$ to be the two state variables that investors care about.
   b. Can show that $\alpha_{i,3} = 0$ for all i.
      (1) Use an argument similar to the one used for the market model above.
      (2) The argument exploits the fact that the two state variables are zero-investment portfolios.
6. Results.
   a. The estimated $\alpha_{i,3}$s are not economically different from zeros and are only marginally significant statistically.
   b. The FF 3-factor model can explain other documented regularities in equity returns that CAPM cannot explain.
   c. The FF 3-factor model can be used to generate better cost of capital estimates than the CAPM.
7. Open questions.
   a. Why do investors care about the covariance of their portfolio return in month t with $r_{SMB}(t)$ and with $r_{HML}(t)$?

V. Market Efficiency.

A. Definition.

1. In an efficient market, the price of a security is an unbiased estimate of its value.
2. Notice that the level of efficiency in a market depends on two dimensions:
   a. The amount of information incorporated into price.
   b. The speed with which new information is incorporated into price.

B. Features

1. To assess the level of market efficiency need to know the security's value; which requires knowing how assets are priced.
2. Market efficiency says that:
   a. if a piece of news is always followed by a another piece of news than the market incorporates the likely impact of the second piece of news at the time that the first piece of news becomes available.
   b. so even if news is correlated, price changes will not be.
   c.

Tomorrow's Price = Today's Price (1 + Expected Return) + Unpredictable Disturbance.

C. Levels of Market Efficiency
   1. Weak form.
      a. Price reflects all information contained in past prices.
      b. So an investor can not use past prices to identify mispriced securities.
      c. Technical analysis:
         (1) refers to the practice of using past patterns in stock prices to identify future patterns in prices.
         (2) is not profitable in a market which is at least weak form efficient.
   2. Semi-strong form.
      a. Price reflects all publicly available information.
      b. So an investor can not use publicly available information to identify mispriced securities.
      c. Fundamental analysis:
         (1) refers to the practice of using financial statements and other publicly available information about firms to pick stocks.
         (2) is not profitable in a market which is at least semi-strong form efficient.
      d. If a market is semi-strong form efficient, then it is also weak form efficient since past prices are publicly available.
   3. Strong form.
      a. Price reflects all available information.
      b. So an investor can not use any available information to identify mispriced securities.
      c. Insider trading:
         (1) refers to the practice of using private information about firms to pick stocks.
         (2) is not profitable in a market which is at least strong form efficient.
         (3) is illegal.
      d. If a market is strong form efficient, then it is also semi-strong and weak form efficient since all available information includes past prices and publicly available information.

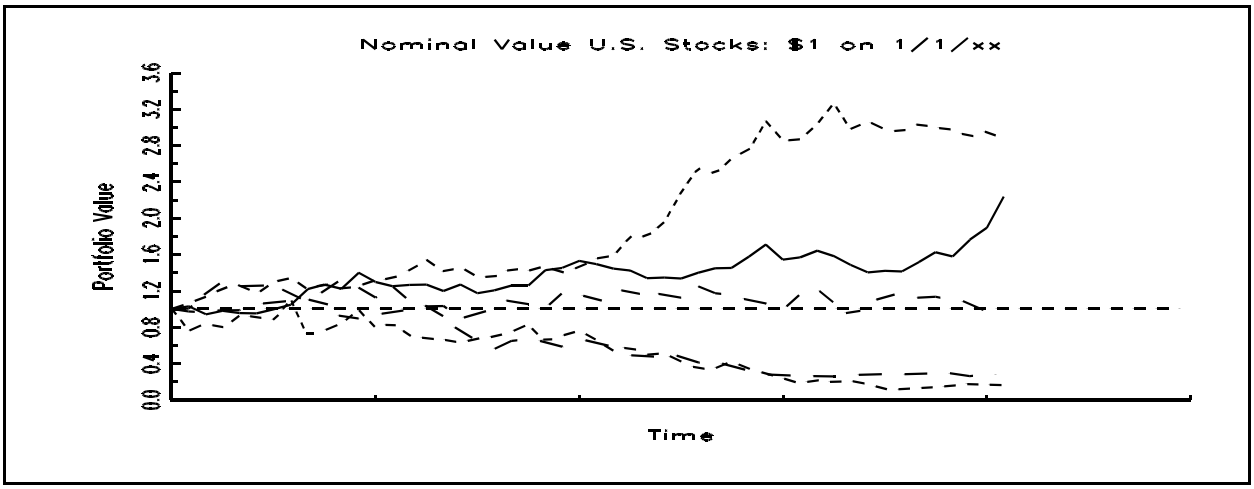
D. Costly Information Acquisition and Costly Trading.
   1. A Contradiction
      a. If markets are efficient, all information is reflected in price.
      b. But then there is no incentive to gather costly information and trade on it.
      c. So how does the information get into price?!.
   2. An Alternate Argument.
      a. Could have an equilibrium where some investors choose to gather information and some do not.
      b. Those that do earn better returns which offset the costs of acquiring the information and trading on it.
      c. The market is not fully efficient in the sense discussed above.

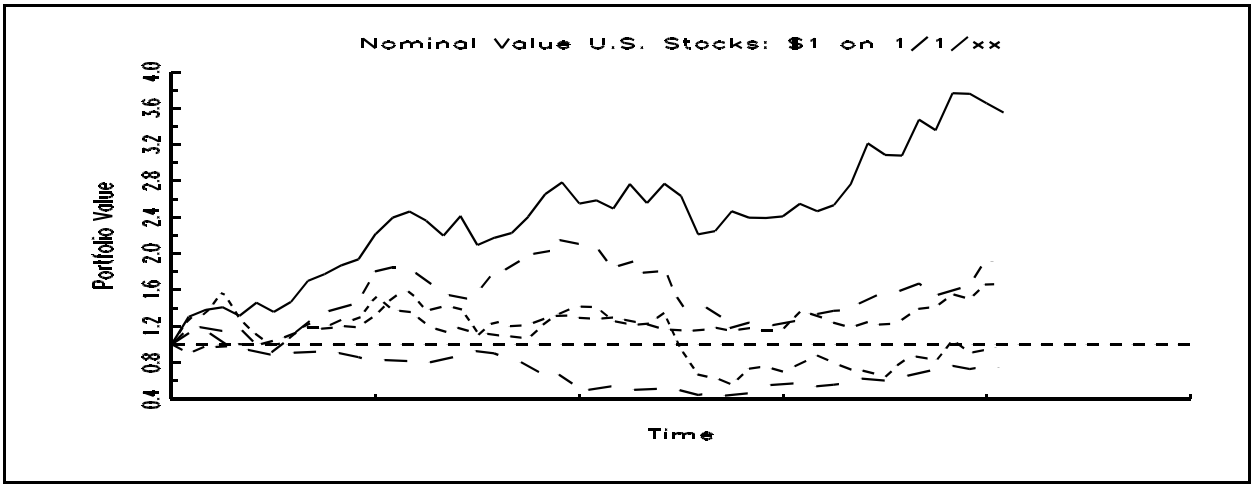
E. How efficient are U.S. financial markets.
   1. Probably semi-strong form efficient but not strong form efficient.
   2. Can find rare examples of semi-strong form inefficiency.

F. Joint Test Problem.
   1. The question whether price fully reflects a given piece of information always depends on the model of asset pricing that the researcher is using. It is always a joint test.
   2. Example: Taking the CAPM as the model of asset pricing, finding a relation between expected return and size after controlling for Beta with respect to the market implies semistrong market inefficiency since size is publicly available. However, taking a multifactor model as the model of asset pricing, the relation between a size and expected return may be due to a stock's size being correlated with the stock's risk loading for a relevant factor.

G. Predictability of Returns.
   1. Can forecast long horizon returns using:
      a. past long horizon returns (negative relation) (p 23).
      b. information variables related to the business cycle (p 23);
         (1) aggregate dividend yield at the start of the return period (positive relation).
         (2) term spread (long term high grade corporate bond yield less one month T-bill rate) which is known at the start of the return period (positive relation).
         (3) these information variables are counter cyclical.
   2. These findings are consistent with two stories:
      a. time varying expected returns and semistrong market efficiency.
      b. constant expected returns and semistrong market inefficiency.

H. Example of Semi-strong Form Inefficiency: Stocks added and deleted from the S&P 500.
   1. see p 24-16.





VI. Market Efficiency: Evidence.

