Mult-Factor Models: Fama-French 3 Factor Model

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CAPM Anomalies

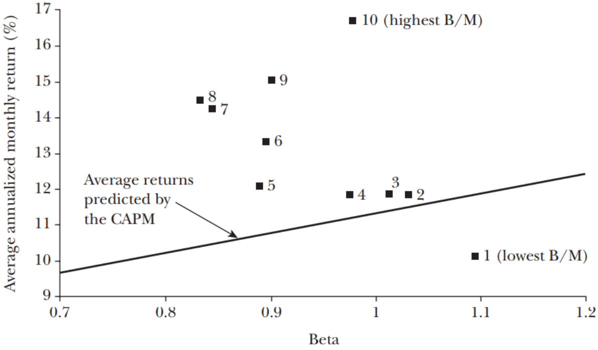
- CAPM states that market risk is the only factor that explains stock returns.
- Does this make sense is reality? (No!)
- Researchers have identified many patterns in stock returns which are inconsistent with the predictions of CAPM $\rightarrow$ CAPM anomalies.

CAPM Anomalies

- Value stocks vs Growth stocks: value stocks outperfrom growth stocks.
- Momentum: stocks with higher returns in the previous year tend to have higher returns.
- Reversal: stocks with poor long-term performance tend to have higher returns.

CAPM Anomalies

Figure 3
Average Annualized Monthly Return versus Beta for Value Weight Portfolios Formed on B/M, 1963–2003



(source: Fama and French(2004, JEP))

- Is is consistent with CAPM?

CAPM Anomalies

- The anomalies imply that market return alone is not enough to explain stock returns.
- (Example)
  - We all experienced that the COVID-19 crisis and its effect on the financial market.
  - The COVID-19 affect stock returns through the market factor, but not all.
  - For example, the crisis may have more severe effects depending on industry, firm-size, etc.
  - Then, can we say that all residuals are firm-specific and can be disversified away?
  - Or, are there additional risk factors to account for it?

Multi-factor Models

- One possible solution is adding more factors to the model:

$$E\left(r_i\right) = \alpha_0 + \sum_{i=1}^{K} \beta_{i,k} F_K$$

  where F's are risk factors.
- If we add enough risk factors, then the residuals($\epsilon_i = r_i - E(r_i)$) are truly firm-specific.
- Then, how can we identify risk factors?

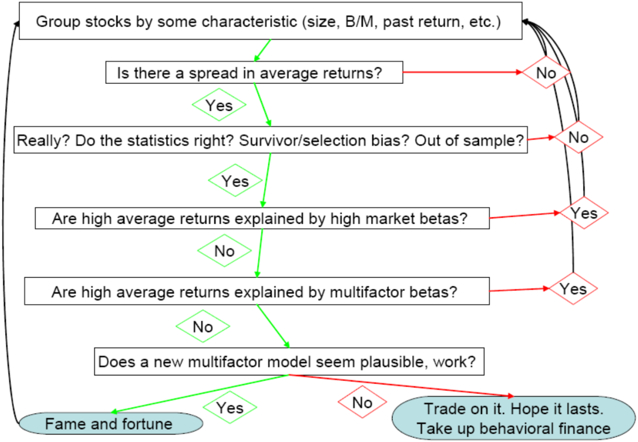
Multi-factor Models

- Arbitrage Pricing Theory (APT)
- Assumptions of APT
  - (1) Returns are generated by a factor model.
  - (2) Law of one price (No arbitrage).
  - (3) There exists enough securities to form well-diversified portfolios that eliminate idiosyncratic risk.
- While APT is less restrictive than CAPM, it does not tell us how many factors there are and what those factors are.

Multi-factor Models

- Identifying risk factors normally takes three steps:
  - (1) Specifying risk factors
  - (2) Build factor-mimicking portfolios
  - (3) Test the explanatory power and risk premium of factor mimicking portfolios.
- Ways to find factors
  - (1) Statistical Analyis
  - (2) Macroenomic approach
  - (3) Firm-characteristic approach

Cochrane's Empirical Asset Pricing Flowchart



Fama-French 3 Factor Model

- Fama and French (1992) identify two more risk factors additional to market risk based on
  - (1) The outperformance of small versus big companies (SMB)
  - (2) The outperformance of high book/value companies versus low book/value companies (HML)
- SMB: Small Minus Big(SMB) is the average return on the three small portfolios minus the average return on the three big portfolios.
- HML: High Minus Low(HML)) is the average return on the two value portfolios minus the average return on the two growth portfolios.
- Fama-French three factor model:

$$E(r_i) - r_f = \beta_m E\left[(r_M) - r_f\right] + \beta_s E\left(SMB\right) + \beta_v E\left(HML\right)$$

Fama-French 3 Factor Model

Market Cap
50th Percentile

Book Value / Market Cap

Small Value	Big Value
Small Neutral	Big Neutral
Small Growth	Big Growth

70th Percentile
30th Percentile

Fama-French 3 Factor Model

- Overall steps
  - (1) Collect data
  - (2) Construct portfolios formed on Size and Value
  - (3) Calculate average returns of each portfolio
  - (4) Calculate SMB and HML
  - (5) Calculate excess returns of each portfolio (including market portfolio)
  - (6) Run regression analysis

Fama-French 3 Factor Model

- (Results)
  - The three factors explained over 90% of average returns
  - Fama and French (1996) show that many of the CAPM anomalies are explained by the three factor model.
  - Cannot explain how SMB and HML are related to economy-wide state varialbles.
  - Cannot explain the momentum anomaly.

Fama-French 3 Factor Model

- How to interprete SMB and HML
  - Market efficiency?
  - If EMH hold, SMB and HML must be proxies for unknown risk factors.
  - However, if they are just results of mispricing, then they are evidences that markets are not efficient.