Asset Pricing and Valuation

Lecture 5: Extensions to CAPM

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Fama and French (3 factor model)

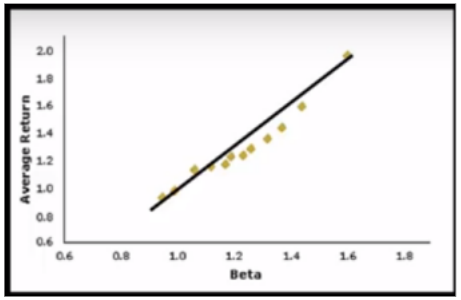
CAPM

CAPM formula

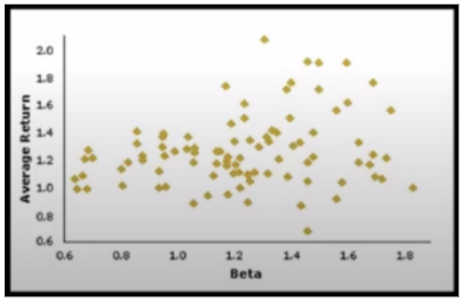
$r_i = r_f + \beta_i(r_m - r_f)$

- Expected return of security i is a function β times the market premium.
- So, in CAPM the expected return of a security is just a function of 1 factor β or systematic risk.
- How exposed is this security to overall changes in the market
- CAPM states expected return is a positive linear function of beta
- CAPM states that β is the only asset specific factor we need to consider when pricing assets.
- Other factors should add no value in estimating expected return.

CAPM



- CAPM Expectations
- When just using market betas we observe a positive linear relationship between expected return and beta



- Adjust the returns for the effects of **size** and **book-to-market equity**

Fama French

- *Used two easily measured variables, size and book-to-market equity, combine to capture the cross-sectional variation in average stock returns associated with market β*
- Found that overtime, 2 types of portfolios had a positive α
- Recall an $\alpha > 0$ means that the returns is higher that what was predicted by the CAPM model.
- After taking these factors into account there seems to be **no** relation between expected return and beta
- Can't draw a line to represent these points.
- Economists say that β is dead

Fama French

$$r_i = R_f + \beta_{i,mkt}(R_m - R_f) + \beta_{i,size}SMB + \beta_{i,value}HML$$

- Capture the sensitivity of asset i to the market risk premium
- Sensitivity of asset i to SMB
- Sensitivity of asset i to HML
- Three β

Factors

Financial Accounting

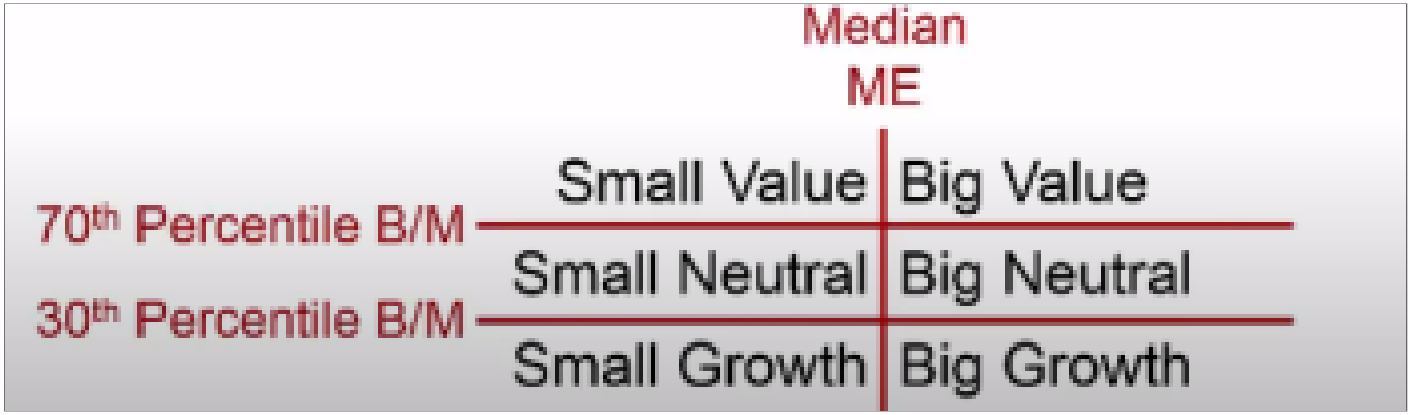
- First need to understand some accounting terms:
- **Book value**: Is the value of the business according to its "books" or financial statements.
  - Consider company A with assets of $100 and liabilities of $80
  - The book value of the company is $20
  - Basically, if the company closed today and sold off all its assets and paid its liabilities, the equity value is worth $20.
- **Market value**: Is the value of the company according to the stock market.
  - Multiple the company's shares outstanding by its current market price
  - Consider company B has 1 million shares outstanding, each share is currently trading for $50, the the company's market value is $50 million.

Financial Accounting

$$\text{Book value of equity} = \text{Assets} - \text{Liabilities}$$
$$\text{Market value of equity} = \text{Shares outstanding} \times \text{Share price}$$
$$\text{Book to market} = \frac{\text{Book value of equity}}{\text{Market value of equity}}$$

- **Book value > Market value**: Market values the company less than its stated value (market lost confidence in the company)
  - stock screen: https://www.marketinout.com/stock-screener/industry.php?picker=price_book_ratio
  - https://www.screener.in/screens/19841/book-value-greater-than-cmp-and-other-factors/
- **Book value < Market value**: Market values the company more than its stated value (market has confidence in the company)
  - Market expects future earnings to be strong
  - Almost all companies have a market value greater than book value
- **Book value = Market value** - The market sees no reason to believe the company's assets are better or worse than what is stated on the balance sheet.
- Note: The market value fluctuates every day in relation to its book value

How are portfolios created?



- Uses 6 portfolios using *size* and *book-to-market*
- How to construct
  - **Vertical line** - Take all stocks in the market, compute the market-value-of-equity and **rank** them.
    - Compute the **median** market value of equity (ME)
    - All stocks with a market value of equity **below** the median are **small cap** stocks
    - Simple way to classify small and big companies
  - **Horizontal line** - Take all stocks in the market, compute the book-value-of-equity and market-value-of-equity
    - Compute the **book-to-market** ratio and **rank** them.
    - Take the 70th and 30th percentiles
    - Stocks above the 70th percentile are **value** stocks
    - Stocks that are below the 30th percentile are **growth** stocks

Value vs Growth

- Taking the book-to-market ratio $\frac{B}{M}$
- When something is of **value** then the market price m is low relative to what we are getting B
  - When m is low we have a high ratio - indicating a **value** stock.
- When something is of **growth** - or a stock which is growing their earnings in the future
- Investors are willing to pay a high price for this growth in earnings
  - M large relative to B and ratio has a low value (**growth stocks** - growing earnings in the future)
  - Investors expect the **future cash flows** to be high and have discounted them back today with a high **PV** (stock price)
  - If investors expected **future cash flows** to be low, then they would pay less for it (indicated by a lower share price)

Factor portfolios

Small minus Big (SMB)

- Compute the average return for each portfolio
- Take average return on 3 portfolios in the **small** category and subtract the average return on the 3 portfolios in the **big** category
- Small minus Big looks like:
$$SMB = \frac{(SmallValue + SmallNeutral + SmallGrowth)}{3} - \frac{(BigValue + BigNeutral + BigGrowth)}{3}$$

High minus Low (HML)

- Looking at the book-to-market ratio
- High ratios are the **value** portfolio - compute average returns (2 portfolios)
- Low ratios are the **growth** portfolio - compute average returns (2 portfolios)
- Subtract the low book to market ratio stocks from the high book to market
$$HML = \frac{(SmallValue + BigValue)}{2} - \frac{(SmallGrowth + BigGrowth)}{2}$$

Factor portfolios

- Long time period 1963 - 1990 (stock returns for companies listed on the NYSE, AMEX and NASDAQ) - with **CRSP** and **COMPUSTAT** data.
- 10 size portfolios using ME (market equity) and 10 book-to-market portfolios

Factor portfolios

- Take shows the monthly returns
- Low book to market (**growth stocks**) - market value is high since investors pay for expected growth in earnings (results in a low ratio)
- As we move to the right of the columns we get high **book-to-market** portfolios **value stocks**
- In the rows, we form 10 portfolios based on market-capitalization (ME)
  - Small stocks (small market cap)
  - Large stocks (large market cap) - Apple, MSFT, GOOGLE etc.
- Want to find *where are the high average monthly returns stocks?*
  - In the top right hand corner - **Small-ME** and **High-BE** (small cap and value stocks)
  - So these are **small, value** portfolios (https://www.morningstar.com/small-value-funds)

Overview of Fama French factors

- Fama French is a multi-factor model (unlike CAPM)
- Contains 3 risk factors
  - Market risk
  - Firm size
    - Small firms outperformed big firms historically
  - Book value
    - High book/market firm outperformed low book/market firms historically

Interpreting Fama French results

- Can go to the Fama French website and extract the pre-computed factors.
- We have the return of the stock market - risk free rate $Mkt - Rf = 3.40\%$
- SMB of 2.05% - i.e. in February of 2019, small cap stocks outperformed larger cap stocks by 2.05%
- HML of -2.67% in the same month High book-to-Market stocks **underperformed** low book-to-market stocks by 2.67%
- The Rf is just a T-Bill for this period.

Month	Mkt_RF	SMB	HML	RF
201808	3.44	1.14	-3.94	0.16
201809	0.06	-2.27	-1.70	0.15
201810	-7.68	-4.78	3.40	0.19
201811	1.69	-0.68	0.30	0.18
201812	-9.57	-2.38	-1.84	0.20
201901	8.40	2.90	-0.46	0.21
201902	3.40	2.05	-2.67	0.18

Historical Factor Portfolios

- Download all data and compute the historic averages
  1926 - 2023
- Market performs 8.09% on average annually
- Small cap stocks outperformed large cap stocks by 2.17%
- High book-to-market stocks outperformed low-book-to-market stocks by 4.36%

mean_annualised_market	mean_annualised_smb	mean_annualised_hml
8.093892	2.172318	4.128452

- So we have 3 risk premiums 8.09% (market risk premium), 2.17% (size risk premium) and 4.36% (book-to-market premium)

Fama French 3 Factor Example 1

- Understanding the econometric output
- Take the company “COF” - Capital One Financial Corp
- Run regression to extract the β
- **Interpretation**
  - $\beta_{MKT} = 1.324720$ - for every 1% increase in the market, the excess return of COF increases by 1.32%
  - $\beta_{SMB} = 0.586681$ - Positive β suggests that COF has a significant positive exposure to small minus big (SMB) factor - i.e. its more **sensitive** to returns of small cap stocks (not actually a small cap stock)
  - i.e. it tends to perform better when smaller firms outperform larger firms
  - $\beta_{HML} = 0.981330$ - Positive β suggests that COF has a significant positive exposure to high minus low (HML) factor (sensitive to high book-to-market)
  - i.e. it tends to perform better when **value** stocks outperform **growth** stocks

$$\text{R\_excess} = -0.006051 + 1.324720 * \text{MKT\_RF} + 0.586681 * \text{SMB} + 0.981330 * \text{HML}$$

Fama French 3 Factor Example 1

- We take our betas
  - $\beta_{MKT} = 1.324720$
  - $\beta_{SMB} = 0.586681$
  - $\beta_{HML} = 0.981330$
- Take today t-bill rate (say, 2.16%)
- Take the historical market premiums
  - 8.09% (market risk premium)
  - 2.17% (size risk premium)
  - 4.36% (book-to-market premium)

$$R_{FF_3} = \text{t-bill} + \beta_{MKT} * \text{market risk premium} + \beta_{SMB} * \text{size risk premium} + \beta_{HML} * \text{book-to-market premium}$$

$$\frac{2.16}{100} + \left(\frac{1.324720 \times 8.09}{100}\right) + \left(\frac{0.586681 \times 2.17}{100}\right) + \left(\frac{0.981330 \times 4.36}{100}\right)$$

```
2.16/100 + sum(
  ((1.324720 * 8.09 ) / 100) +
    ((0.586681 * 2.17) / 100) +
    ((0.981330 * 4.36 ) / 100))
```

```
[1] 0.1842868
```

- Expected return of 18.42%

Fama French 3 Factor Example 1

- We have 3 positive β and we multiplied these by 3 positive positive risk premiums (mkt, size and book-to-market)
  - This tells us that COF is expected to have a high expected return.
  - Its sensitive to all 3 risk factors wo we should expect a higher return.
- However, this is just for a single stock.
- Doing the same thing but to multiple stocks we form a portfolio of expected returns
- We then apply our weights to the portfolio expected returns to form our portfolios expected return.

Fama French 3 Factor Example 2 Large value

- Using Walmart
- Has low *market risk* i.e. β from CAPM is x 1
- Has a low (negative) SMB β - so it tells us that Walmart is very big and does not have exposure to small cap movements
- Negative β relating to HML - Walmart has a low B-M ratio (https://finance.yahoo.com/quote/WMT/key-statistics?p=WMT)
- Price-to book is 5.48 - so 1/5.48 = 0.18 P/B ratio has a low P/B ratio)
- So a negative exposure to SMB and HML is driving down the expected returns to Walmart

```
2.16/100 + sum(
  ((0.5219777 * 8.09 ) / 100) +
    ((-0.5544551 * 2.17) / 100) +
    ((-0.1795804 * 4.36 ) / 100))
```

```
[1] 0.04396661
```

So we expect Walmart returns to be 4.63%

Fama French 3 Factor Example 3 - Small value stock

- **Small Value** stock
- https://www.morningstar.com/small-cap-value-stocks
- FHN - First Horizon National Corp - Market Cap 7.4 Billion
- Its Price to book ratio is small
- Market β is less than 1.
- Positive exposure to SMB and HML
  - Tells us that FHW is small and has a positive exposure - when small cap stocks outperform large cap stocks, FHW will outperform by 1.07
  - Positive exposure to HML - when value stocks outperform growth stocks, FHW will outperform by 1.504

```
2.16/100 + sum(
  ((0.878890 * 8.09 ) / 100) +
    ((1.078278 * 2.17) / 100) +
    ((1.504182 * 4.36 ) / 100))
```

```
[1] 0.1816832
```

- Expected return is 18.16

Fama French 3 Factor Example 4 - Large Growth

- MSFT
- https://www.morningstar.com/large-cap-growth-stocks
- $\beta_{MKT} = 0.98$ so for every 1% the stock moves 0.98%
- $\beta_{SMB} = -0.66$ - negative β suggests that NVDA has a significant negative exposure to small minus big (SMB) - i.e. it is less **sensitive** to small cap stock movements.
  - Tends to perform worse when small stocks outperform large stocks
- $\beta_{HML} = -0.3772$ - negative β suggests that NVDA has a significant negative exposure to HML - not sensitive to high-book-to-market
- NVDA is a large growth stock - so it is not sensitive to small cap movements and not sensitive to value movements

Fama French 3 Factor Example 5 - Small Growth

- TITN (Titan Machinery)
- https://www.forbes.com/advisor/investing/best-small-cap-stocks/

- $\beta_{MKT} = 1.32$ so expected to move more than the market - $\beta_{SMB} = 1.18$ positive, so has significant exposure to SMB - more **sensitive** to returns of small cap stocks (i.e. it is a small cap) - $\beta_{HML} = 1.04$ - positive, so has a positive exposure to HML - sensitive to high book-to-market stocks (i.e. it is a growth stock)

Fama French 3 Factor Example 5 - Big Value

- A large company with a high book-to-market ratio (big value stocks)
- AT&T Inc. (T)
- $\beta_{MKT} = 0.58$ - so for every 1% increase in the market PG increases by 0.58%
- $\beta_{SMB} = -0.34$ - negative, so PG tends to **under perform** when small-cap stocks outperform - i.e. so has a negative exposure to SMB - not sensitive to small cap movements (AT&T is a large cap)
- $\beta_{HML} = 0.52$ - positive - Expected to perform better when value stocks outperform growth stocks
- AT&T is a large value stock - so it is not sensitive to small cap movements and is sensitive to value movements

Using FF for ETF valuations

- ETF: **VBK** - Vanguard Small-Cap Growth ETF
- https://investor.vanguard.com/investment-products/etfs/profile/vbk#portfolio-composition
- $\beta_{MKT} = 1.031$ - so for every 1% increase in the market VBK increases by 1.031%
- $\beta_{SMB} = 0.639$ - positive - so the ETF performs better when small-cap stocks outperform large-cap stocks
  - Consistent with the ETF being a small-cap ETF
- $\beta_{HML} = -0.13$ - negative - the ETF under performs when value stocks outperform growth stocks
  - Consistent with the ETF being a growth ETF

Event studies

- Mergers and Acquisitions
- Equity or debt issues
- Leveraged-buyouts
- Look at the markets reaction to these **events**
- Suppose we want to know the effect of a Merger on shareholders value
- Look at a sample of firms who previously engaged in a merger
- Look at the announcement return - the abnormal return
  - i.e. the return beyond the expected return without the announcment

Event studies

- To estimate a normal return we can run:

  $r_{it} = \alpha_i + \beta_i r_{mkt} + \epsilon_{it}$
  # Event studies {style="font-size: 75%;"}
- For each form we collect the price data before the announcement
- Estimate α and β using an OLS regression
- So obtain our *normal expected* return

  $E[r_i] = \hat{\alpha}_i + \hat{\beta}_i r_{mkt}$
  - Observe our *abnormal return*
  $\hat{r}_i = r_i - E[r_i]$
  - Once we have an estimate of our abnormal return we can estimate what future abnormal returns may look like.

Lazy Prices

- Excess return (CAPM) - 0.63 (Q1) to 0.92% (Q5)
  - So we gain an excess return above the benchmark or risk-free rate (i.e. 0.63 excess)
- Three Factor ranges from -0.15% to 0.18% - negative to positive and significant in higher quintiles - higher similarity correlates with better performance
  - i.e. documents which do not change YoY record better performance.