A Factor-Based Approach to Asset Management

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Factor Risk Premium

- Assets earn high returns (risk premiums) to compensate investors for the losses they incur during bad times (i.e., because they are exposed to underlying factor risks).

Theory of Factor Risk

Assets that crash during bad times are risky $\Rightarrow$ they must reward their holders with high risk premiums.

- Each factor defines a different set of bad times, for example
  1. Bad economic times (e.g., periods of high inflation and low economic growth)
  2. Bad times for investments (e.g., periods when aggregate market or certain investment strategies perform badly)
- Investors exposed to losses during bad times are compensated by risk premiums in good times.

Factor Risks

- **Factor risks manifest during bad times, such as the recent financial crisis:**

Table 6.1: Returns of Asset Classes in 2008

Cash	Three-month T-bill	1.3%
Core Bonds	Barcap aggregate index	5.2%
Global Bonds	Citigroup World Government	10.9%
TIPS	Citigroup US Inflation Linked	-1.2%
Emerging Market Bonds	JPM Emerging Markets Bond Index	-9.7%
US High Yield	Merill Lynch High Yield Master	-26.3%
Large Cap Equity	S&P 500	-37.0%
Small Cap Equity	Russell 2000	-33.8%
International Equity	MSCI World ex US	-43.2%
Emerging Markets Equity	IFC Emerging Markets	-53.2%
Public Real Estate	NAREIT Equity REITS	-37.7%
Private Real Estate	NCREIF Property Index	-16.9%
Private Capital	Venture Economics	-20.0%
Equity Hegde Funds	HFRI Equity Hedge Index	-20.6%
Fixed Income Hedge Funds	HFRI Fixed Income Index	-17.8%
Commodities	Dow Jones AIG Commodity Index	-35.7%

- The simultaneous poor performance of several asset classes is consistent with an underlying factor model in which many asset classes are exposed to the same factors.

Insights

- **Factors matter, not assets**: Investing right requires looking through asset class labels to understand the factor content.

- **Assets are bundles of factors**: equities and government bonds can be considered factors themselves; corporate bonds, hedge funds and private equity contain different amounts of equity risk, volatility risk, interest rate risk, and default risk.

- **Different investors need different risk factors**: Each investor has different preferences, or risk aversion coefficients, for each different source of factor risk..

Factor Theory of Investing

Specifies different types of underlying factor risk, where each different factor represents a different set of bad times.

Outline

1. Factor Investing: The Big Picture
   - Factor Theory
   - Factor Risks
   - Insights

2. Factor Models: An Example
   - CAPM

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Outline

The Most Basic Factor Risk Premium Theory: CAPM

CAPM

The relevant measure of risk associated with investing in an asset is how the asset covaries with the market portfolio - the beta of the asset (not its volatility).

- 75% of CFOs employ the CAPM in actual capital budgeting decisions (Graham and Harvey (2001)), despite its shortcomings.

Lessons from the CAPM

1. Hold the factor (market portfolio), not an individual asset.
2. Each investor has her own optimal exposure to factor risk.
3. The average investor holds the market.
4. The factor risk premium has an economic story:

$$E(r_m) - r_f = \overline{\gamma}\sigma_m^2$$

5. Risk is factor exposure:

$$
\begin{aligned}
E(r_i) - r_f &= \frac{Cov(r_i, r_m)}{Var(r_m)}\left[E(r_m) - r_f\right] \\
&= \beta_i\left[E(r_m) - r_f\right]
\end{aligned}
$$

6. Assets paying off in bad times have low risk premiums.

Lesson 1: Hold the Factor

- The CAPM states that only one factor exists, the market portfolio (where each stock is held in proportion to its market capitalization).
- $\Rightarrow$ holding the factor corresponds to investing in a market index fund.
- The market factor is the best, most-well diversified portfolio investors can hold under the CAPM (it has the highest Sharpe ratio and represents systematic risk).
- Individual stocks are exposed to the market factor (that carries a risk premium), but also have idiosyncratic risk (that is not rewarded by a risk premium since it can be diversified away).
- Investors can diversify away the idiosyncratic part and increase their returns by holding the market factor portfolio, rather than any other combination of individual stocks.

The CAPM implies that the market portfolio is held by every investor (except those that are infinitely risk averse and hold only risk-free assets).

Equilibrium

- Equilibrium occurs when investor demand for assets is exactly equal to supply.
- The market is the factor in equilibrium because everyone holds the mean-variance efficient (MVE) portfolio (maximum Sharpe ratio tangency portfolio).
- Since all investors hold the MVE portfolio, the MVE portfolio becomes the market portfolio.

- Equilibrium ensures that the factor (market portfolio) will have a risk premium (that is a function of the underlying investors' preferences).
- $\Rightarrow$ the risk premium reflects the full setup of all people in the economy.
- $\Rightarrow$ It will disappear only if the economy totally changes (not because a few clever hedge funds trade the factor).

Lesson 2: Each Investor Has Her Own Optimal Exposure of Factor Risk

- All investors hold the market portfolio, just in different proportions:

$$\omega_m = \frac{E\left(r_m\right) - r_f}{\gamma \sigma_m^2}$$

- $\Rightarrow$ they hold different proportions of the risk-free asset and the market portfolio.

- $\Rightarrow$ each individual investor has a different amount of factor exposure.

Lesson 3: The average investor holds the market

- The market portfolio represents the average holdings across investors.
- The tangency point between the Capital Allocation Line (CAL) and the mean-variance frontier represents an investor who holds 100% in the MVE portfolio.
- The risk aversion corresponding to this 100% portfolio position is the risk aversion of the market.

Lesson 4: The Factor Risk Premium has an Economic Story

- The risk premium on the market is given by

$$E\left(r_m\right) - r_f = \overline{\gamma}\sigma_m^2$$

where $\overline{\gamma}$ is the risk aversion of the 'average' investor.
- $\Rightarrow$ as the market becomes more volatile, the expected return of the market increases and equity prices simultaneously fall.
- Example:
  - Volatility was very high and equity prices very low in 2008 and 2009.
  - Expected returns in this period were very high (and realized returns were indeed high in 2009 and 2010).

Intuition: Under the CAPM, investors have mean-variance preferences (they dislike variances and like expected returns) $\Rightarrow$ it is intuitive that the market risk premium is proportional to the market variance.

Lesson 5: Risk is Factor Exposure

- The CAPM implies that any stock's risk premium is proportional to the market risk premium:

$$E(r_i) - r_f = \frac{Cov(r_i, r_m)}{Var(r_m)} [E(r_m) - r_f]$$

$$= \beta_i [E(r_m) - r_f]$$

Intuition: mean-variance investing is all about diversification benefits. Beta - the CAPM's measure of risk - is a measure of the lack of diversification potential.

- High beta assets act like the diversified portfolio the investor already holds, so they require high expected returns to be held by investors.

- Low beta assets, on the other hand, pay off when the market performs poorly and, therefore, have great diversification benefits $\Rightarrow$ investors do not need to be compensated very much for holding them.

Lesson 6: Assets Paying Off in Bad Times Have Low Risk Premiums

- The risk premium is a reward for how an asset pays off in bad times.
- In the CAPM, bad times correspond to low (or negative) market returns.
- High beta assets lose value when the market loses and gain when the market gains. Investors are risk averse and overweight bad times $\Rightarrow$ gains during good times do not cancel out the losses during bad times $\Rightarrow$ high beta assets are risky and require high expected return to be held in equilibrium by investors.
- Converse argument holds for low beta assets.