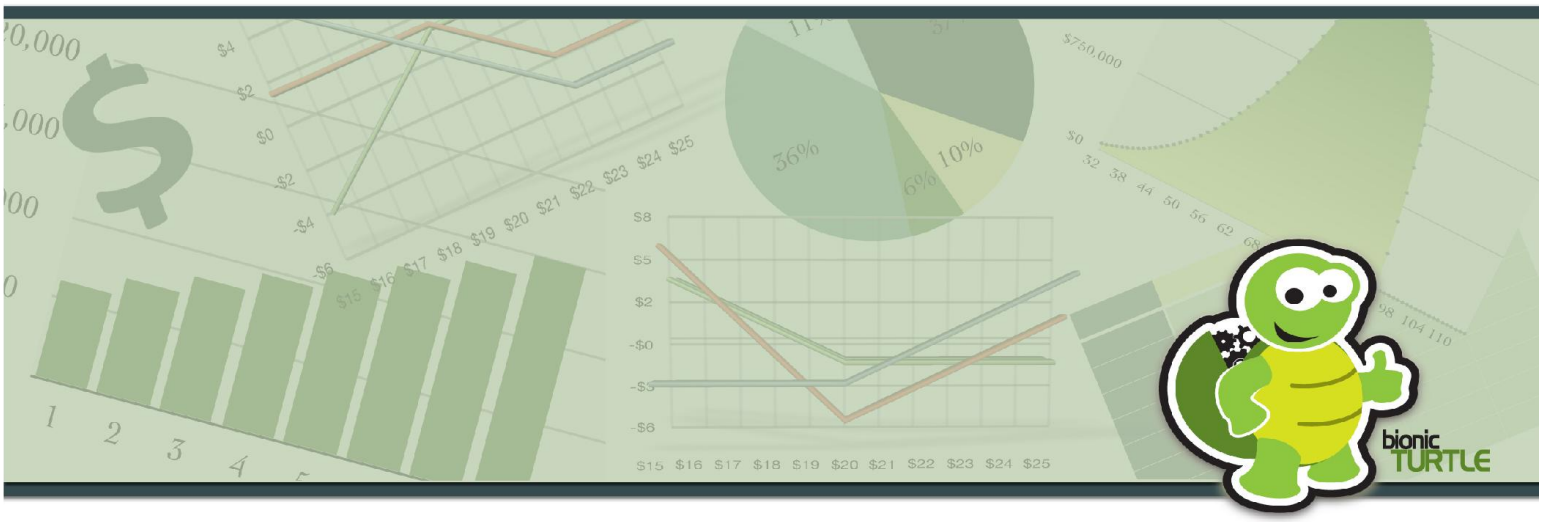


P2.T9. Risk Management & Investment Management

Andrew Ang, Asset Management: A Systematic Approach to Factor Investing

Bionic Turtle FRM Study Notes

Ang, Chapter 6: Factor Theory

Ang, Chapter 7: Factors

Ang, Chapter 10: Alpha

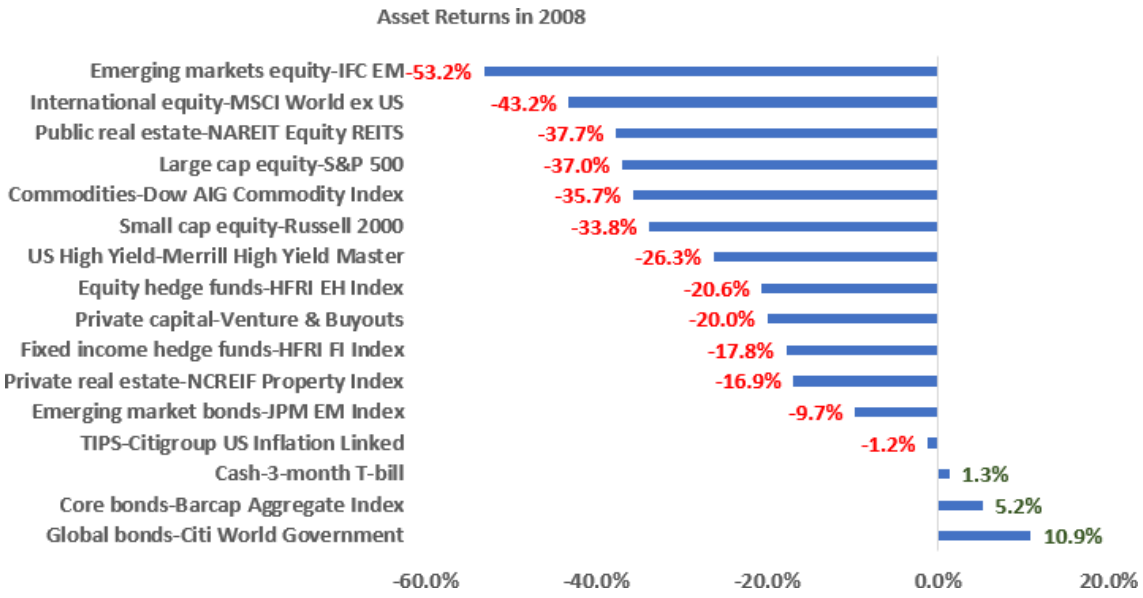
Ang, Chapter 6: Factor Theory

- **Provide examples of factors that impact asset prices and explain the theory of factor risk premiums.**
- **Describe the capital asset pricing model (CAPM) including its assumptions and explain how factor risk is addressed in the CAPM.**
- **Explain implications of using the CAPM to value assets, including equilibrium and optimal holdings, exposure to factor risk, its treatment of diversification benefits, and shortcomings of the CAPM.**
- **Describe multifactor models, and compare and contrast multifactor models to the CAPM**
- **Explain how stochastic discount factors are created and apply them in the valuation of assets.**
- **Describe efficient market theory and explain how markets can be inefficient.**

Provide examples of factors that impact asset prices and explain the theory of factor risk premiums.

Most assets plunged in value during the global financial crisis (GFC). **Figure 1** below shows returns during 2008 sorted (from worst to best) by asset class. For example, US large-cap equities returned -37.0% and small-cap equities returned -33.8%. Only three asset classes managed to produce positive returns: cash (+1.3%) and safe-haven bonds (+5.2% and +10.9%)[1].

Figure 1

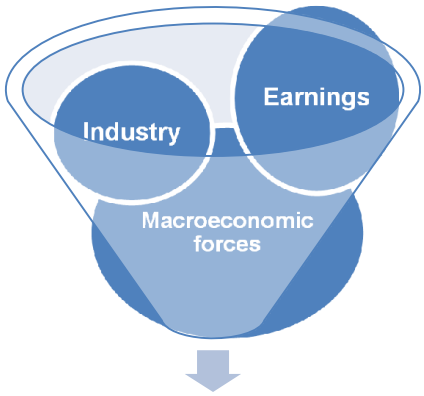


[1] Andrew Ang, Asset Management: A Systematic Approach to Factor Investing (New York, NY: Oxford University Press, 2014). Our Excel chart of Ang's data.

Many factors affect asset prices, including the market. The question here is which ones matter most and by how much. Once one understands the various risk factors, one can then explain why some assets earn much higher returns than the risk-free rate (e.g., US Treasury bills). Some examples of investment style factors and macroeconomic factors include:

Figure 2

- Investment style factors:
  - Value-growth investing;
  - Low volatility investing; and
  - Momentum portfolios
- Macroeconomic factors:
  - Economic growth (GDP);
  - Job growth;
  - Interest rates;
  - The exchange rate; and
  - Inflation.



Theory of factor risk premiums

Every factor represents a risk to asset prices. To account for the risk, assets carry risk premiums – which is referred to as the **theory of factor risk premiums**.

It likely goes without saying, but each factor contributes a *different kind of risk* to asset prices. Investors willing to take the risks – including the real potential of the downside – are compensated for taking the risks with higher risk premiums. For example, suppose high inflation causes a downturn in the economy and thereby causes a decline in asset prices. The risk of poor returns when the economy sours suggests that investors require a higher premium for risky assets during good times. The theory of factor risk premiums can be summarized, at least partially, by the following points:

- **Although the assets themselves matter, the factors behind the assets matter much more.** Essentially, smart investing involves finding the most important factor "ingredients" that explain selected asset returns.
- **Not just one factor matters.** Most assets respond to a multiplicity of factors. For instance, hedge funds depend upon many types of risk, including equity risk, interest rate risk, volatility risk, bankruptcy risk, and default risk. Additionally, it is often the case that **assets themselves are factors**, such as is the case with equities and government fixed-income securities.
- **Different investors require different risk factors**: Investors are as varied as there are assets in the world. When it comes to risk, these differences show up as preferences for different risk factors. Some investors may prefer to allocate a large portion of their portfolio to triple-weighted bull equity index funds (highly risky), whereas others may opt for large-cap value stocks with less upside and downside risk.

Describe the capital asset pricing model (CAPM), including its assumptions, and explain how factor risk is addressed in the CAPM.

Perhaps the most well-known model of asset pricing is the Capital Asset Pricing Model (CAPM). The CAPM model is one approach professionals use to describe the relationship between expected return and systematic risk. The model is built on the theory of diversification and that individuals have mean-variance utility functions. The CAPM is useful when assets are imperfectly correlated – that imperfection means that diversification can improve the investor's risk-return trade-off. Additionally, diversification is thought to generally improve the Sharpe ratios and it is generally thought that the "most diversified portfolio" is the market portfolio.

Essentially, the CAPM is an initial attempt to explain the "overall" factor risk premium theory using just one factor – the market portfolio. Perhaps the most important calculation that stems from the CAPM is an asset's risk premium. The asset's risk premium is the asset's beta, which represents the compensation an asset must receive to compensate for potential losses during bad times. One important aspect of the CAPM that researchers must keep in mind is that the risk of an asset captured by the **CAPM is dependent solely on how the asset moves in relation to other assets *and* the market as a whole rather than on the asset's own volatility**.

The CAPM modeling framework posits that the **only factor that exists is the market portfolio**. The makeup of the market portfolio is simply the proportion of each stock's market capitalization is to the overall market's capitalization. By holding the market portfolio (the only factor!) rather than the individual stocks, investors can diversify from the non-systematic or idiosyncratic risks. By holding the market portfolio, an investor will not be rewarded with a risk premium. For such an investor, the only risk remaining would be the systematic risk. For investors holding more than the market portfolio, the asset's beta captures the risk premium compared to the market portfolio.

The CAPM framework makes the following assumptions, all of which are violated in real-life empirical studies:

- The only consideration investors make stems from their financial wealth.
- The optimal portfolio choice depends on an investor's income and liabilities.
- The utility functions of investors have is mean-variance. This implies that investors are:
    - Risk-averse; and
    - Diversify to enhance returns and minimize risks.
- The time period covered by the CAPM is a single period. The CAPM is not meant to explain returns over a dynamic, long-horizon.
- All investors have the same expectations (referred to as homogeneous). This assumption means that investors view the expected means, volatilities and correlations of securities the same.
- Markets are assumed to be frictionless with no taxes or transactions costs.
- Individual investors are price takers. There are no market imperfections.
- Information is free and all investors have access to the same information.

Graphical depiction of the CAPM

As stated in the prior section, the CAPM assumes that investors having mean-variance utility, leading to the assumption that diversification plays an important role. In mean-variance analysis, a portfolio of assets is generated such that the **expected return is maximized for a given level of risk** or alternatively, **the risk is minimized for a given level of expected return**. The mean-variance frontier is the set of all such optimal portfolios, as shown in the following figure.

The following figure captures the mean-variance frontier with the capital allocation line (CAL). The CAL line plots the possible combinations of risk-free and risky assets. When the two lines (the CAPM and the CAL) touch – referred to as the "point of tangency" – one has arrived at the maximum Sharpe ratio. Please note that in the following figure, the CAL line becomes the CML. The reason why is addressed in the next section.

Under the CAPM, investors hold the risk-free asset and the same mean-variance efficient (MVE) portfolio but in different proportions. The difference stems from investors' level of risk aversion. All investors theoretically lie somewhere on the CAL. Assuming all investors hold the same view on means, volatilities, and correlations, the MVE portfolio is the best that can be held by a given investor with a given level of risk tolerance. In equilibrium, the MVE portfolio becomes the market factor.

Figure 3