Risk Return Trade-off

Capital Asset Pricing Model

Multifactor Risk and Return Models

The Endowment Model

Liability Driven Model

The Efficient Frontier
Risk Return Trade-off

- The risk return trade-off principle holds that the return on an investment rises as the potential risk involved in it increases.
- The possibility of higher returns is greater if the investor is willing to take high amounts of risk and the returns are generally lower if the investor is not willing to take much risk.
- Hence, according to the risk return trade-off, an investor can only earn higher return if he is willing to face the possibilities of losses by taking higher risk.
An investor seeking higher returns will generally have his portfolio concentrated around growth stocks. These stocks hold the potential of providing with high returns, but also feature a great amount of risk.

An investor seeking low returns might invest in government securities or income assets. Such assets provide low returns and are potentially less risky.

A rational investor will optimise his portfolio by investing in assets with the lowest risk levels for a given amount of return, or with the asset providing the highest amount of return for a given level of risk.
Risk Return Trade-off

**Capital Asset Pricing Model**

Multifactor Risk and Return Models

The Endowment Model

Liability Driven Model

The Efficient Frontier
Capital asset pricing model (CAPM)

- CAPM is the simplest factor model which attempts to explain the return of an individual security or portfolio.
- It considers only one factor, i.e., the market return as the explanatory variable.
- CAPM determines the theoretical rate of return of an asset. It helps in deciding if the asset should be added to a well-diversified portfolio.
- The CAPM model considers the asset’s sensitivity to the systematic (or market) risk, expected return of the market and expected return of the risk-free asset.
According to the model, risk premium of an asset is the function of its sensitivity to market return (beta) as well as market risk premium. Expected return of any asset equals the risk-free rate of return plus beta adjusted market risk premium.

\[
E(R_i) = R_f + \beta_i [E(R_m) - R_f]
\]

where:

\(E(R_i)\): Expected return of the asset

\(R_f\): Risk free rate of interest

\(\beta_i\): Asset's sensitivity to market return

\(E(R_m)\): Expected return of the market
Assumptions of CAPM

- Assumes that investors are rational and risk averse; they desire to maximize their own utility.
- Investors can borrow and lend at the risk-free rate of return.
- Assumes that there are no taxes or transaction costs involved. Information is freely and readily available to all investors.
- Each investment can be divided into small parts and is liquid as there are always enough buyers and sellers in the market.
- Assumes that the investors are price takers i.e., they have no power to influence the prices.
- Investors have homogeneous expectations and assumes that all the information is available to all the investors worldwide at the same time.
Security Market Line (SML)

• The Security Market Line (SML) is a graphical representation of the CAPM formula.

• We use the security market line (SML) for individual securities and its relation with the expected return and market risk (beta) to show the pricing of individual securities according to the security risk class.
CAPM and SML relation

• According to CAPM, securities must fall on the SML line.

• If a security trades below the SML line, then it becomes very attractive for the investors, who would bid its price up until its expected return rise to the level justified by its systematic risk.

• Similarly, if a security trades above the SML line, then it is very expensive and the investors would sell it until its expected return falls on the SML line.
Advantages of CAPM

• It is a simple model and assumes that the investor holds a diversified portfolio, which eliminates the idiosyncratic risk to some extent.

• It considers the systematic risk, which is left out of other models such as the dividend discount model.

• The CAPM model helps in to find out if the securities are undervalued or overvalued. If the security is giving a return of more than its required rate of return, it is undervalued and should be bought.

• If a security is giving a return less than its required rate of return, it is overvalued and should be sold.
Drawbacks of CAPM

• Beta or the measure of systematic risk, is related to past returns. The same relationship may or may not hold in future.

• Market anomalies are not best explained by the CAPM model. There are other factors like size and value (Fama-French factors) which can explain such anomalies.

• CAPM model assumes that investors have homogeneous expectations but in reality, it is unlikely that the investors have homogeneous expectations.
Risk Return Trade-off

Capital Asset Pricing Model

**Multifactor Risk and Return Models**

The Endowment Model

Liability Driven Model

The Efficient Frontier
Multifactor Risk and Return Models

• Multi-factor model is a generalized form of a CAPM with where more than one factors are involved.

• The Capital Asset Pricing Model (CAPM) is a single factor model which attributes portfolio performance to market return. A multi factor model may involve not only the market factors but also econometric, fundamental or statistical factors.
Formula

\[ R_i = \alpha_i + \beta(1) \times F1 + \beta(2) \times F2 + \ldots + \beta(N) \times FN + \epsilon_i \]

Where:

* \( R_i \) is the returns of portfolio \( i \)
* \( R_m \) is the market return
* \( F(1, 2, 3 \ldots N) \) is each of the factors used
* \( \beta \) is the sensitivity with respect to each factor
* \( \varepsilon \) is the error term
* \( \alpha \) is the intercept
Some of the well-known factors are value, growth, momentum, quality, size and market.

Following is a description of some widely-used asset pricing factor models:
Fama-French three Factor Model

As per the model, variation in stock returns can be explained by three factors: size, value and market risk.

\[ E(R_i) - R_f = \alpha + \beta_1 [E(R_m) - R_f] + \beta_2 SMB + \beta_3 HML + \varepsilon \]

Where:

- \( E(R_i) \): Expected return of the asset
- \( R_f \): Risk free rate of interest
- \( \beta_i \): Asset’s sensitivity to each factor
- \( \varepsilon \) is the error term

SMB: Small [market capitalization] minus Big

HML: High [book-to-market ratio] minus Low
Fama French 3 Factor Model plus Carhart’s “Momentum factor

- Fama-French three factor model was not able to explain all the market phenomenon.
- To solve this, a new factor namely momentum was added to the FF 3 factor model.

\[ E(R_i) - R_f = \alpha + \beta_1 [E(R_m) - R_f] + \beta_2 SMB + \beta_3 HML + \beta_4 UMD + \epsilon \]

- Here UMD is momentum factor. It’s calculated by excess return of one-year return momentum versus contrarian stocks.
Asset Class Risk Factors

While analyzing multi-asset class portfolios, each asset class can be mapped to different risk and performance factors corresponding to that asset class.
Equities

Risk for a global equity portfolio can be broken down onto four broad category factors:

<table>
<thead>
<tr>
<th>Category</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market</td>
<td>MSCI All Country World Index</td>
</tr>
<tr>
<td>Sector</td>
<td>Energy, Material, Industrials, Consumer discretionary, Technology</td>
</tr>
<tr>
<td>Region</td>
<td>US, EU, Asia Pacific, Latin America</td>
</tr>
<tr>
<td>Style</td>
<td>Growth, Value, Momentum, Quality, Size</td>
</tr>
</tbody>
</table>
Three major performance and risk factors for a fixed income portfolio are duration, convexity and credit spread.

LIBOR curves can be used as benchmarks and issuer curves are constructed as spreads to the relevant LIBOR curve.

Performance of fixed income portfolios can be compared using these three factors.
Commodities

• For commodities funds, traditionally single composite commodity index is used as a risk and performance factor.

• Major factors for a commodity portfolio are term structure, time series momentum, cross sectional momentum and composite commodity market risk.

• **Term structure** refers to how the future price compares to the current price.

• **Time series momentum** is momentum of a single commodity.

• **Cross sectional momentum** refers to the momentum of a commodity relative to others.
Hedge Funds

- Hedge funds use alternative strategies to generate performance.
- Fung and Hsieh (2004) design a seven-factor model that specifically helps to measure the unique exposures created by hedge funds.
- The authors identify seven factors: 2 equity-oriented risk factors, 3 trend-following risk factors, and 2 interest rate-related risk factors.
Risk Return Trade-off

Capital Asset Pricing Model

Multifactor Risk and Return Models

The Endowment Model

Liability Driven Model

The Efficient Frontier
The Endowment model

- University endowments have been leaders in multi-asset class investing for over two decades.

- Through an approach that is focused on diversification while simultaneously holding a large exposure to alternative asset classes, the largest university endowments have consistently achieved attractive annual returns with moderate levels of risk.
Endowment Type 1

• Endowments are true long-term investors with a technically unlimited time horizon.

• Endowments generally believe that less liquid assets provide a good source of excess returns (alpha) and that their long-term investment horizon allows them to bear the liquidity risk of such investments.
Endowment Type 2

• The factor allocation shows that many of asset allocation classifications on the left-hand side do not paint a fully descriptive picture of the risks within each strategy.

• Over 90% of the exposure can be attributed to simple equity, fixed income and real asset risk factors.

• The asset allocation approach focuses more on the differences in return streams among the different strategies rather than the commonality among underlying risk drivers.
Endowment Type 3

• Fung and Hseih (2004) found that seven asset based style factors could explain up to 80 percent of monthly return variations of diversified hedge fund portfolios (as proxied by indexes of hedge funds and funds of hedge funds).

• Because these factors are directly observable from market prices, this model provides a standardized framework for identifying differences among major hedge funds.

• In a nutshell factor analysis provides a practical approach to aggregate true underlying risk exposures enabling transparency and insight for model portfolio.
Applications of Multifactor Models

- Multi-factor models are used to construct portfolios with certain characteristics, such as risk, or to track indexes.

- Multifactor models are widely used for manager’s performance evaluation, product selection, asset pricing and risk management.

- It helps the investor assess the true selection capability of a portfolio manager after taking account all the risk exposure.

- the models are used to cover all the risks of a portfolio and rebalance the factor exposure.
Risk Return Trade-off

Capital Asset Pricing Model

Multifactor Risk and Return Models

The Endowment Model

**Liability Driven Model**

The Efficient Frontier
Liability driven model

• Liability driven investment (LDI) is investment for securing cash flows for liabilities that will arise in the future.

• It is done to secure enough assets that could fund both present and future liabilities.

• Liability driven investing is most common in defined-benefit pension plans because these types of pensions generally create too much liabilities which should be funded in the future with enough resources.

• Liability driven investing requires passive management rather than active management.
Risk Return Trade-off

Capital Asset Pricing Model

Multifactor Risk and Return Models

The Endowment Model

Liability Driven Model

The Efficient Frontier
The Efficient Frontier

• The efficient frontier is the set of optimal portfolios that offers the highest expected return for a defined level of risk or the lowest risk for a given level of expected return.

• Portfolios that lie below the efficient frontier are sub-optimal, as they do not provide enough return for the level of risk.
Each point on this line represents an optimal combination of securities that maximizes the return for any given level of risk (standard deviation).

These dots represent portfolios that are inferior to the portfolios on the efficient frontier—they either offer the same returns but with more risk, or they offer less return for the same risk.
Efficient frontier graph with SML

• Security Market Line is the graphical representation of the CAPM. SML shows the different levels of market risk plotted against the expected return of the security.

• SML plots the relationship between market risk (beta) and the expected return of the security.

• Expected return is shown as the function of beta.

• The x-axis indicates the systematic or the market risk in terms of beta and the y-axis shows the expected return of the individual security.

• The slope of the security market line represents the market risk premium \([E(R_m) - R_f]\). SML is considered a single factor model of the asset price.
Security Market Line

Expected Return

\[ E(R_M) \]

\[ R_F \]

\[ \beta_M = 1 \]

\[ \beta \]

Slope = \( \frac{E(R_M) - R_F}{\beta_M - 0} = E(R_M) - R_F \)
Efficient frontier graph including both traditional asset classes and alternative asset classes

- Alternative Investments differ from traditional asset classes because they are comparatively less transparent, more illiquid and involves a high level of risk.

- Since, alternative asset classes are highly risky they provide higher expected returns than the traditional asset classes.

- An investor who wants to invest in alternative asset classes (high risk bearing) but wants to diversify his risk can add traditional assets (low risk bearing) to his portfolio to create a well-diversified portfolio which reduce will reduce the investor’s total risk and increase his total expected returns.
Assumptions

The efficient frontier and modern portfolio theory have many assumptions that may not represent the market conditions accurately. Some of the assumptions used are:

• Asset returns distribution is normal. In relativity, it may be non-normal with positive kurtosis and negative skew.
• Investors have unlimited access to borrow and lend at risk free rate.
• Investors are rational and avoid risk whenever possible.
“Risk comes from not knowing what you’re doing”

-Warren Buffet
THANK YOU