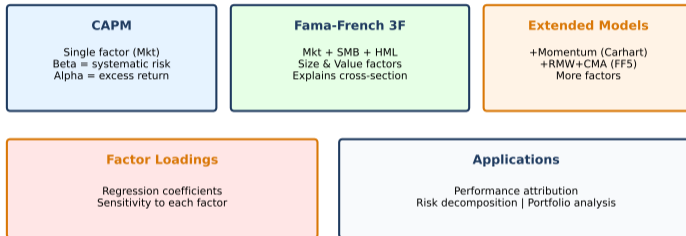


## Lesson 24 Summary: Factor Models

Data Science with Python – Key Concepts

Data Science Program

## Factor Models in Finance



$$r_j - r_f = \alpha + \beta_{mkt}(r_m - r_f) + \beta_{smb} * SMB + \beta_{hml} * HML + \epsilon$$

Factor models explain asset returns through common risk factors

## Capital Asset Pricing Model:

- **Equation:**  $r_i - r_f = \alpha + \beta(r_m - r_f) + \epsilon$
- **Beta:** Sensitivity to market risk
- **Alpha:** Excess return (skill or mispricing)

## Key insight:

Expected return is proportional to market risk (beta).

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CAPM is the foundation of modern portfolio theory

**Extends CAPM with size and value:**

- **MKT:** Market excess return (same as CAPM)
- **SMB:** Small Minus Big (size premium)
- **HML:** High Minus Low (value premium)

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**FF3 explains cross-sectional return differences**

### **Additional factors:**

- **Momentum (Carhart):** Past winners continue winning
- **Profitability (RMW):** Robust minus weak
- **Investment (CMA):** Conservative minus aggressive

### **Fama-French 5-Factor:**

Adds RMW and CMA to the original three factors.

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More factors explain more variation but may overfit

## Regression-based approach:

- **Method:** OLS regression of returns on factors
- **Coefficients:** Factor loadings (betas)
- **Intercept:** Alpha (unexplained return)

## Time window:

Typically 36-60 months of historical data.

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Factor loadings change over time; use rolling windows

## Interpreting alpha:

- **Positive alpha:** Outperformance vs factor model
- **Zero alpha:** Returns explained by factors
- **Statistical test:** Is alpha significantly different from 0?

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Alpha is the return attributed to skill or luck

## Attribution analysis:

- **Factor risk:**  $\beta^2 \times \sigma_{factor}^2$
- **Idiosyncratic risk:** Unexplained variance
- **Total risk:** Sum of factor and specific risks

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Factor models help understand where risk comes from

## Data sources:

- **Kenneth French Library:** Free FF factor returns
- **AQR:** Alternative factor data
- **Bloomberg/Refinitiv:** Commercial providers

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French library data is the academic standard

## Choosing factors:

- **Adjusted R-squared:** Compare explanatory power
- **Factor significance:** Are loadings significant?
- **Parsimony:** Prefer simpler models

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More factors is not always better

### Essential Implementation:

<b>Task</b>	<b>Approach</b>
Estimate loadings	OLS regression on factor returns
Get alpha	Regression intercept
Test significance	statsmodels p-values
Attribution	Multiply loadings by factor returns
Rolling betas	Use rolling window regression

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Factor models connect financial theory to linear regression