# Asset Pricing Model Comparison and Market Interpretation

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# Research Motivation

- Modern finance relies on models that link expected returns to risk exposures.
- I estimate two competing frameworks:
  - Capital Asset Pricing Model (CAPM)
  - Fama–French Five–Factor Model (FF5)
- The goal is to understand:
  - Which model better explains returns?
  - How do exposures differ across sectors?
  - What do alphas imply for risk–adjusted performance?

# Assets and Data

- Five sector–diversified assets:
  - Apple (AAPL) – Technology
  - JPMorgan (JPM) – Financials
  - ExxonMobil (XOM) – Energy
  - Walmart (WMT) – Consumer Retail
  - XLV – Healthcare ETF
- Daily returns: 2019–2024.
- Factor data downloaded from the Kenneth French database.
- Returns converted to excess returns (asset minus risk–free rate).

# Methodology Overview

- For each asset, I estimate both:

$$R_{it} - R_{ft} = \alpha + \beta_{MKT}(MKT - RF)_t + \epsilon_t$$

$$R_{it} - R_{ft} = \alpha + \beta_{MKT}(MKT - RF)_t + \beta_{SMB}SMB_t + \beta_{HML}HML_t + \beta_{RMW}RMW_t + \beta_{CMA}CMA_t + \epsilon_t$$

- I compare:
  - Alphas (risk–adjusted performance)
  - Betas (factor sensitivities)
  - $R^2$ (model fit)
- Python implementation ensures reproducibility.

# Example Python Structure

```
data = load_prices_and_ff5(tickers, start, end)
summary_df = run_factor_regressions(data, tickers)
summary_df.to_csv("factor_regression_summary.csv")
make_factor_visuals(summary_df)
```

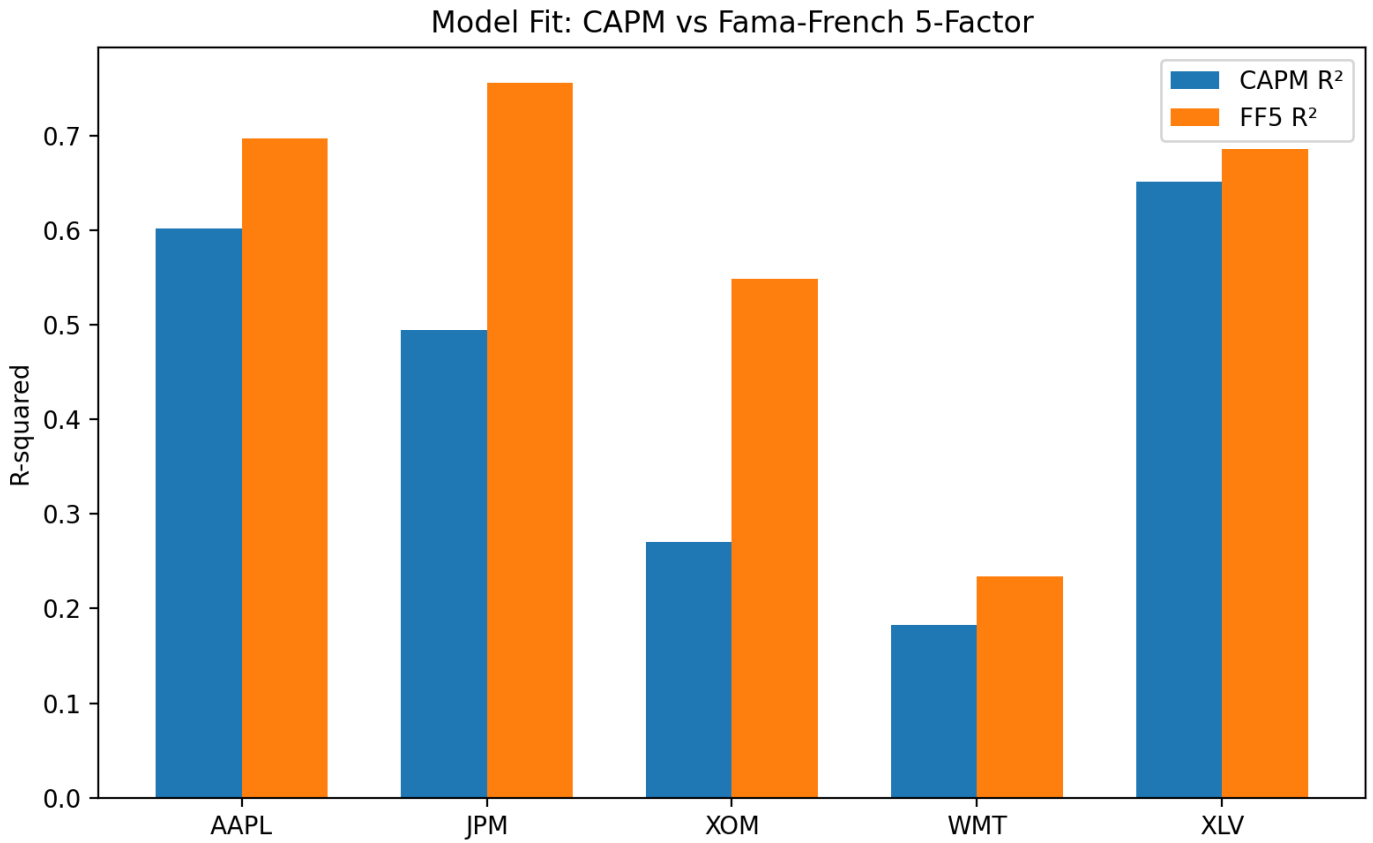
*Note: Full code is available in the project script and uses pandas, statsmodels, yfinance, and matplotlib.*

# Regression Output Summary

| Ticker | CAPM $\beta_M$ | CAPM $R^2$ | FF5 $\beta_M$ | FF5 $R^2$ |
|---|---|---|---|---|
| AAPL | 1.16 | 0.60 | 1.26 | 0.70 |
| JPM | 1.04 | 0.49 | 1.05 | 0.76 |
| XOM | 0.81 | 0.27 | 0.89 | 0.55 |
| WMT | 0.44 | 0.18 | 0.53 | 0.23 |
| XLV | 0.69 | 0.65 | 0.75 | 0.69 |

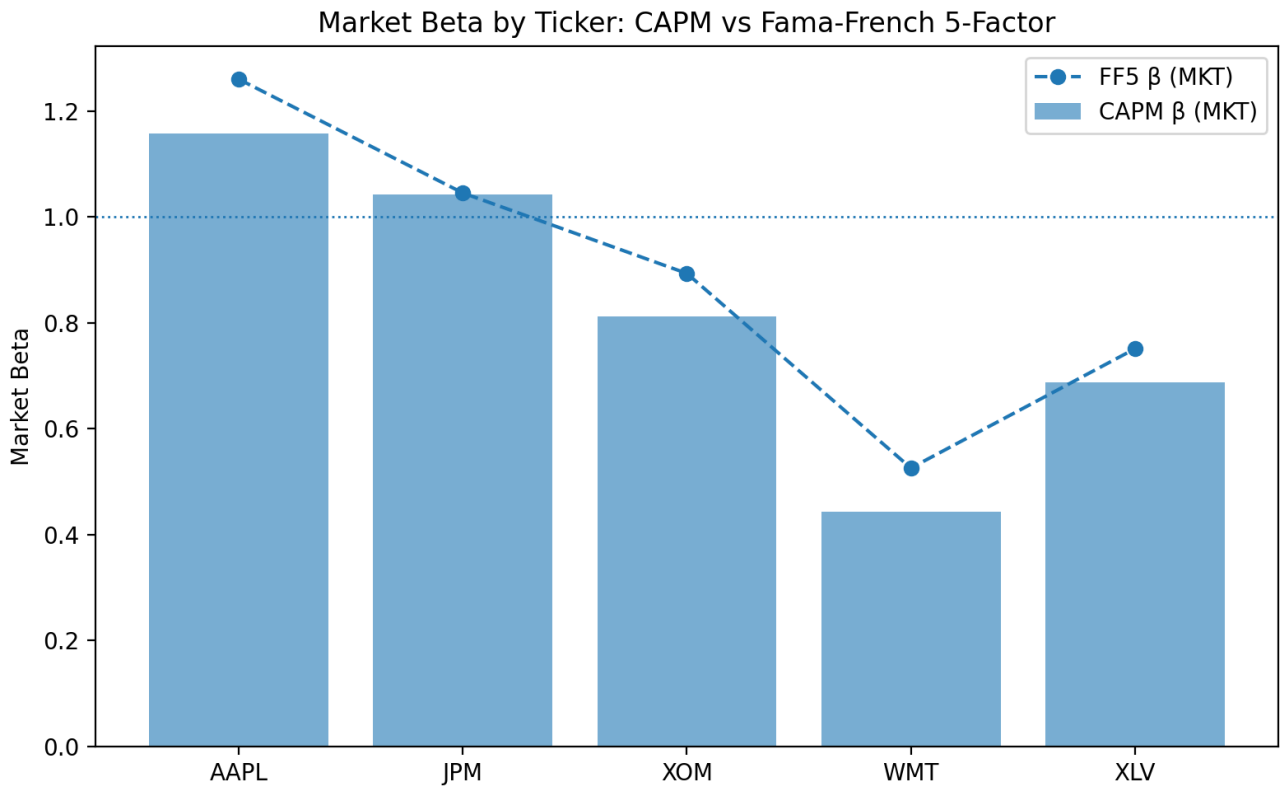
**Interpretation:** Across every asset, adding Fama–French factors increases $R^2$, meaning multi–factor exposure explains returns better than market exposure alone.

# CAPM vs FF5 Fit Visual




- FF5 materially improves explanatory power, especially for JPM and XOM.
- This suggests the single–beta CAPM omits important sources of priced risk.

# Market Betas: CAPM vs FF5




- AAPL behaves as a high–beta growth stock (beta $> 1$).
- WMT and XLV load less on market risk (betas well below 1).
- FF5 market betas are slightly higher because other factors absorb noise, revealing the core market sensitivity more clearly.

# FF5 Factor Exposures and Significance

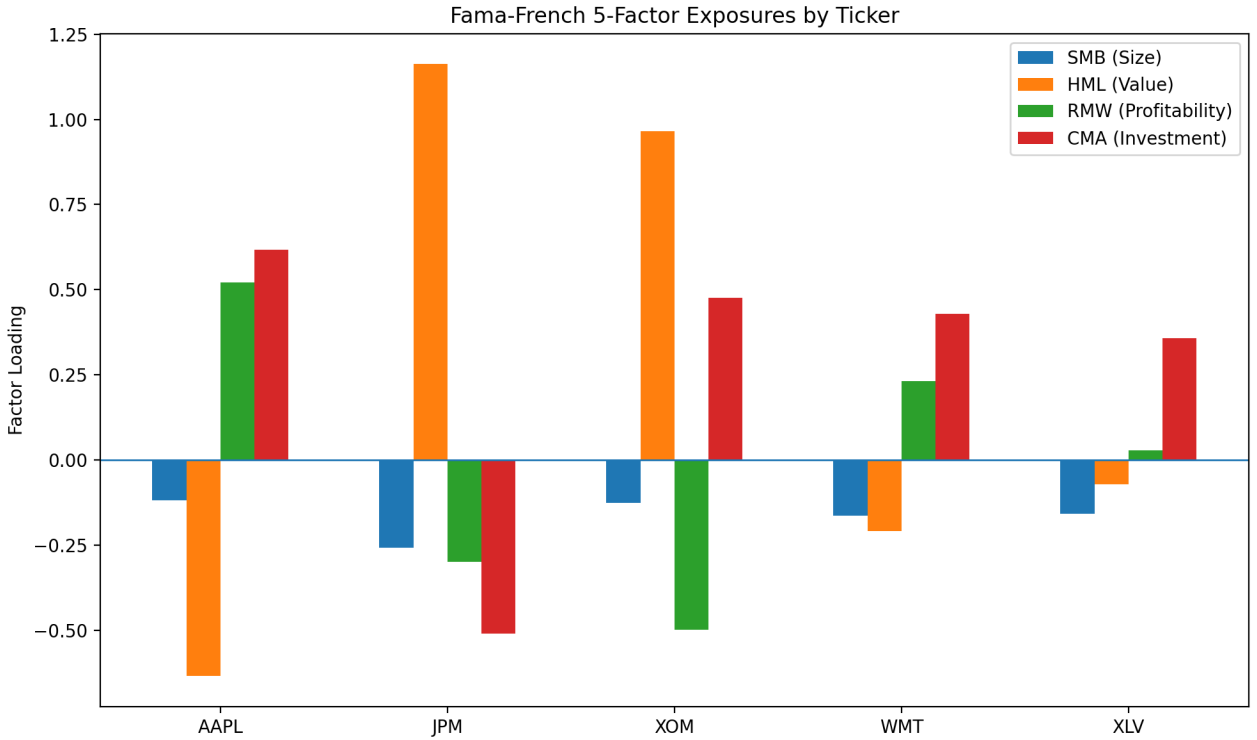
| Ticker | MKT | SMB | HML | RMW | CMA |
|---|---|---|---|---|---|
| AAPL | 1.26*** | -0.12** | -0.63*** | 0.52*** | 0.62*** |
| JPM | 1.05*** | -0.26*** | 1.16*** | -0.30*** | -0.51*** |
| XOM | 0.89*** | -0.13* | 0.96*** | -0.50*** | 0.48*** |
| WMT | 0.53*** | -0.16*** | -0.21*** | 0.23*** | 0.43*** |
| XLV | 0.75*** | -0.16*** | -0.07** | 0.03 (ns) | 0.36*** |

**** p<0.01, ** p<0.05, * p<0.10, (ns) not significant*

**Insights:**

- The value factor (HML) is systematically important across assets.
- Profitability (RMW) is significant in tech and retail, but not for the healthcare ETF.
- Investment (CMA) plays a strong role for all assets, reflecting how capital intensity and reinvestment shape returns.

# FF5 Factor Loading Visual




- AAPL and WMT load heavily on profitability and investment.
- JPM and XOM load strongly on value, consistent with "value stock" intuition.
- XLV's profitability sensitivity (RMW) is near zero, suggesting healthcare returns are less driven by relative earnings strength.

# Interpreting Alpha Estimates

- CAPM alphas are small and mixed in sign across assets.
- FF5 alphas are also close to zero once I control for all five factors.
- Based on the regression output, these alphas are not strongly statistically significant.
- **Interpretation:** Once risk exposures are measured properly, excess risk–adjusted performance is close to zero, which is consistent with (approximate) market efficiency.

# Sector Narrative

- **AAPL:** Growth exposure, significant profitability and investment betas, negative value loading.
- **JPM:** Deep value exposure; negative size beta consistent with large–cap banking.
- **XOM:** Cyclical value stock with strong HML and investment exposure.
- **WMT:** Stable retailer whose returns are shaped by profitability and investment discipline.
- **XLV:** Defensive healthcare exposure with moderate market beta and limited profitability loading.

# Binomial Option Pricing: Pfizer (PFE)

**Setup:**

- Underlying: Pfizer (PFE).
- Valuation date: Nov 26, 2025; expiry: Nov 26, 2026 ($T \approx 1$ year).
- Dividend yield $q = 3\%$ per year; tree steps $N = 500$.
- Volatility estimated from recent PFE returns (20–day window used below).

**Prices (20–day vol, $\sigma \approx 28.31\%$, $r \approx 3.75\%$):**

| Strike | Euro Call | Amer Call | Euro Put | Amer Put |
|---|---|---|---|---|
| 25 | 3.22 | 3.23 | 2.34 | 2.37 |
| 26 | 2.77 | 2.78 | 2.86 | 2.90 |
| 27 | 2.37 | 2.37 | 3.42 | 3.47 |

# Interpreting the Binomial Results

- **American vs European:**
  - American calls are slightly more valuable than European calls (about \$0.01).
  - American puts are more valuable than European puts (about \$0.03–\$0.05).
- **Economic intuition:**
  - Dividends plus the right to exercise early justify a premium for American options.
  - Early exercise is especially relevant for in–the–money puts, which is where we see the largest differences.
- **Connection to the rest of the project:**
  - Factor models explain expected stock returns; the binomial model shows how those stock dynamics translate into derivative prices.

# Final Takeaways

- The Fama–French 5–factor model outperforms CAPM in explaining returns for all five assets.
- Factor exposures align with sector characteristics (growth vs value, cyclical vs defensive).
- Alphas are small and mostly insignificant, consistent with limited opportunities for persistent abnormal returns.
- The binomial model for PFE confirms theoretical predictions about American vs European option pricing under dividends.

# Questions

Thank you!