Empirical Methods in Finance

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Stock: AMD | Comparison Stock: Berkshire Hathaway

Question 1: Single Stock CAPM — AMD

We used AMD monthly returns over a 5-year period and merged with the Fama-French factors to get Mkt-RF and RF. The CAPM regression is:

$$R\_AMD - RF = \alpha + \beta\,(Rm - RF) + \varepsilon$$

Coef Std Err t-stat p-value 95% CI

α 0.0047 0.019 0.247 0.806 [−0.034, 0.043]

β (Mkt-RF) 1.8923 0.396 4.781 0.000 [1.094, 2.691]

R^2 Adj. R^2 F-stat p(F) N

0.347 0.332 22.86 2.07e-05 45

1. Beta Interpretation

Beta is 1.89, meaning AMD moves about 1.89% for every 1% move in the market. It has higher systematic risk than the market — not surprising for a semiconductor company that tends to swing hard with economic cycles.

2. Alpha Significance

Alpha is 0.0047 with a p-value of 0.806, which is far above 0.05. We fail to reject H_0: $\alpha = 0$. There is no evidence AMD earns abnormal returns on a risk-adjusted basis over this period.

3. R-squared

$R^2 = 0.347$, so about 34.7% of AMD's return variation is explained by the market. The remaining 65.3% is firm-specific risk. This is not a particularly high R^2 and shows AMD carries a lot of idiosyncratic risk.

4. Expected Excess Return (Market excess return = 10%)

$E[R - RF] = 0.0047 + 1.8923 \times 0.10 = 0.1939 \approx 19.4\%$

Question 2: Comparing Two Stocks — AMD vs. Berkshire Hathaway

We ran CAPM for both stocks over the same period. AMD is tech; Berkshire is finance/insurance.

AMD Berkshire

α 0.0047 (p=0.806) 0.0057 (p=0.352)

β 1.8923 0.8460

R^2 0.347 0.512

N 45 45

1. Beta Comparison

AMD's beta of 1.89 is much higher than Berkshire's 0.85. AMD is an aggressive, high-risk stock that amplifies market moves. Berkshire, with beta below 1, is more defensive — it moves less than the market. For investors, AMD offers higher expected return in bull markets but larger drawdowns in downturns. Berkshire is more stable, which makes sense given its diversified holding structure.

2. F-test for Different Betas

H_0: $\beta_{AMD} = \beta_{BRK}$

F-stat p-value Conclusion

6.3459 0.0136 Reject H_0 at 5%

We reject the null. The betas are statistically different — AMD and Berkshire have meaningfully different systematic risk exposures, consistent with operating in very different industries.

Question 3: Fama-French Three-Factor Model — AMD

$R\_AMD - RF = \alpha + \beta_1(Mkt\text{-}RF) + \beta_2(SMB) + \beta_3(HML) + \varepsilon$

Coef Std Err t-stat p-value

α 0.0065 0.019 0.334 0.740

β_1 (Mkt-RF) 1.8126 0.403 4.495 0.000

β_2 (SMB) −0.3085 0.649 −0.475 0.637

β_3 (HML) −0.8511 0.426 −1.996 0.053

Model R^2 Adj. R^2

CAPM 0.347 0.332

FF3 0.409 0.366

1. Does adding SMB and HML improve R^2?

R^2 goes from 0.347 to 0.409, an improvement of about 6.2 percentage points. The adjusted R^2 also rises from 0.332 to 0.366, so adding the two factors does improve fit even after the penalty for extra parameters. That said, the improvement is modest.

2. F-test: Joint Significance of SMB and HML

H_0: $\beta_2 = \beta_3 = 0$

F-stat p-value Conclusion

2.1491 0.1295 Fail to reject H_0 at 5%

Even though R^2 improves, the joint F-test says SMB and HML are not statistically significant together. The improvement in fit is not large enough to be meaningful for AMD specifically.

3. SMB vs. HML Sensitivity

SMB coefficient is −0.31 (p = 0.64) — not significant. AMD does not have a clear size tilt. HML is −0.85 (p = 0.053) — borderline significant and negative, meaning AMD behaves more like a growth stock. This makes intuitive sense given AMD's high valuation and growth expectations. AMD is more sensitive to the value factor than the size factor.

4. How does alpha change?

CAPM alpha was 0.0047 (p = 0.806); FF3 alpha is 0.0065 (p = 0.740). It increases slightly because the HML factor absorbs some of the return pattern, causing the intercept to shift. Neither is significant. The addition of SMB and HML does not reveal any hidden alpha — AMD still does not show abnormal risk-adjusted performance.

Question 4: Industry Portfolio Analysis — Technology vs. Healthcare

Using Ken French's 5 Industry Portfolios (value-weighted monthly), we ran the FF3 model on Technology (HiTec) and Healthcare (Hlth).

α −0.0011 (p=0.063) 0.0001 (p=0.911)

β_1 (Mkt-RF) 0.9918 (p<0.001) 0.8731 (p<0.001)

β_2 (SMB) 0.0364 (p=0.072) −0.0879 (p=0.005)

β_3 (HML) −0.3036 (p<0.001) −0.1774 (p<0.001)

R^2 0.860 0.661

N 1183 1183

1. Which industry has higher market beta?

Technology has the higher beta at 0.9918 vs Healthcare at 0.8731. Tech moves almost one-for-one with the market and has greater systematic risk. Healthcare is more defensive — demand for medical services does not fall as sharply in a downturn.

2. Size Factor (SMB) Exposure

Healthcare has a significant negative SMB loading of −0.0879 (p = 0.005), meaning it behaves like large-cap stocks. This makes sense — the healthcare portfolio is dominated by large-cap pharma and insurance companies. Tech's SMB is positive but only marginally significant (p = 0.072), suggesting a slight tilt toward smaller companies in the portfolio.

3. F-test for Equal Market Betas

H_0: β_Tech = β_Health

H_0: β_Tech = β_Health

F-stat p-value Conclusion

34.2443 0.0000 Reject H_0 at 1%

Strong evidence that the two industries have different market betas. This is not a sampling fluke — Tech and Healthcare genuinely carry different levels of systematic risk.

4. Which industry to overweight in a recession?

Healthcare. With a lower beta (0.87 vs 0.99), it falls less in a market downturn. If the market drops 10%, Tech loses roughly 10.0% while Healthcare loses about 8.7%. Healthcare demand is relatively inelastic — people still need medical care in a recession. Tech spending tends to get cut early. The lower HML loading on healthcare also means it is less exposed to value/growth cycle swings. For defensive positioning, Healthcare is the better choice.

Question 5: Fama-French Five-Factor Model — AMD

$$R\_AMD - RF = \alpha + \beta_1(Mkt\text{-}RF) + \beta_2(SMB) + \beta_3(HML) + \beta_4(RMW) + \beta_5(CMA) + \varepsilon$$

	CAPM	FF3	FF5
α	0.0120	0.0159	0.0151
β_1 (Mkt-RF)	1.9499	1.7850	1.7757
β_2 (SMB)	—	0.2818	−0.4894
β_3 (HML)	—	1.0946	−0.8003
β_4 (RMW)	—		0.3237
β_5 (CMA)	—		0.4197
R^2	0.277	0.359	0.364
Adj. R^2	0.264	0.323	0.302
AIC	−57.47	−60.31	−56.75
N	57	57	57

1. Are all five factors jointly significant?

H_0: $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$

Method	F-stat	p-value
Python	5.8396	0.0002
Manual	5.8396	0.0002

Yes. F = 5.84, p = 0.0002. We reject the null — the five factors together are jointly significant in explaining AMD's excess returns.

2. Do RMW and CMA add explanatory power?

H_0: $\beta_4 = \beta_5 = 0$

F-stat p-value Conclusion

0.2008 0.8187 Fail to reject H_0

No. F = 0.20, p = 0.82. RMW and CMA add essentially nothing beyond the three-factor model for AMD. The profitability and investment factors are not relevant for this stock.

3. Test $\beta_2 = \beta_3$ (SMB coefficient equals HML coefficient)

H_0: $\beta_2 = \beta_3$

Method F-stat p-value

Python 0.0601 0.8073

Manual 0.0601 0.8073

F = 0.06, p = 0.807. We cannot reject that SMB and HML coefficients are equal for AMD. Even though both are negative, they are statistically indistinguishable from each other.

4. Which model best describes AMD's returns?

The three-factor model is the best fit. The five-factor model's adjusted R^2 (0.302) is actually lower than the three-factor model (0.323), and its AIC (−56.75) is worse than FF3 (−60.31). The incremental test showed RMW and CMA are insignificant. CAPM has the weakest fit. FF3 strikes the best balance between explanatory power and parsimony.

Question 6: Long-Term Reversal Effect

We used the 10 portfolios formed on prior 60–13 month returns from Ken French's website. P1 = past losers, P10 = past winners.

1. Average Monthly Returns

Portfolio Avg Monthly Return

Loser (P1) 1.6886%

Winner (P10) 0.9468%

Past losers outperform past winners on average — consistent with DeBondt and Thaler (1985).

2. Long-Short Reversal Strategy

Long-Short Return = 1.6886% − 0.9468% = 0.7418% per month

3. t-test for Statistical Significance

H_0: Mean reversal premium = 0

Mean Std Error t-stat p-value

0.7418% 0.1495% 4.9606 ≈ 0.000

t = 4.96, p ≈ 0. We strongly reject the null. The reversal premium is statistically significant over the full sample.

4. 20th vs. 21st Century

Period Mean t-stat p-value

20th Century 0.9623% 5.1923 ≈ 0.000

21st Century 0.1333% 0.5749 0.5656

The reversal effect was strong in the 20th century (t = 5.19) but completely disappears in the 21st century (t = 0.57, p = 0.57). The premium is no longer statistically distinguishable from zero after 2000. This likely reflects the effect being traded away as it became well-known, along with faster information processing by markets.

5. CAPM Regression on Long-Short Portfolio

Coef t-stat p-value

α 0.2628% 1.7820 0.0749

β (Mkt-RF) 0.2984 10.7737 <0.001

R^2 0.049 — —

Alpha is 0.26% per month but not significant at 5% (p = 0.075). The beta is small (0.30) and the R^2 is only 4.9%, meaning market risk barely explains the strategy's returns. The reversal premium is mostly unexplained by market risk, which points more toward a behavioral explanation — investor overreaction — rather than a risk premium.

Question 7: Is the Value Premium Dead?

We downloaded the 100 portfolios sorted by book-to-market and used the extreme portfolios: P1 (lowest B/M, growth) and P10 (highest B/M, value).

1. Growth vs. Value Portfolios

Portfolio B/M Avg Monthly Return

P1 — Growth Low 0.949%

P10 — Value High 1.096%

P10 is the value portfolio (high B/M) and P1 is the growth portfolio (low B/M). Over the full sample value outperforms growth on average, consistent with the original Fama-French finding.

2. Long-Short Value Portfolio

Value Premium = 1.096% − 0.949% = 0.007% per month (≈ 0.08% annualized)

The premium over the full sample is essentially zero, which already signals the value anomaly has weakened considerably.

3. t-tests by Period

Period Mean t-stat p-value

20th Century (pre-2000) 0.132% 0.407 0.684

21st Century (2000–2024) −0.197% −0.470 0.639

Neither period produces a statistically significant value premium. In the 20th century the premium is positive but weak (p = 0.68). In the 21st century it actually turns negative — growth outperforms value — though also insignificant (p = 0.64). These results are partly driven by the specific portfolio construction using 10×10 double sorts rather than the direct HML factor.

4. Formal Test: Is the Premium Different Across Centuries?

H_0: μ_{20}th = μ_{21}st

Method t-stat p-value

Python 0.621 0.535

Manual 0.621 0.535

t = 0.621, p = 0.535. We cannot reject that the value premium is the same across centuries. Even though the sign flipped, the difference is not statistically significant.

5. Conclusion: Is Value Dead?

The statistical evidence from our data does not support a robust value premium in either century. However, calling value 'dead' is probably too strong a conclusion. A few things are worth considering.

Book value has become a worse measure of firm value over time. Intangible assets — software, IP, brand — are not on the balance sheet under GAAP, which means firms like Apple or Google look like 'growth' stocks by B/M even though their true earning power is enormous. The HML factor may just be capturing something different today than it did in the 1960s.

The 2010s were a particularly bad decade for value. Low interest rates pushed investors toward growth stocks, whose distant cash flows are more sensitive to the discount rate. As rates rose post-2022, value stocks partially recovered.

On balance, we think the value premium has weakened but is not gone. The measurement is outdated, and once intangibles are properly accounted for, studies tend to find a stronger premium. The underperformance of the past 15 years is real but likely reflects both structural changes and a long stretch of unfavorable macro conditions rather than a permanent death of the anomaly.