Testing Asset Pricing Models

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Motivation and Model Overview

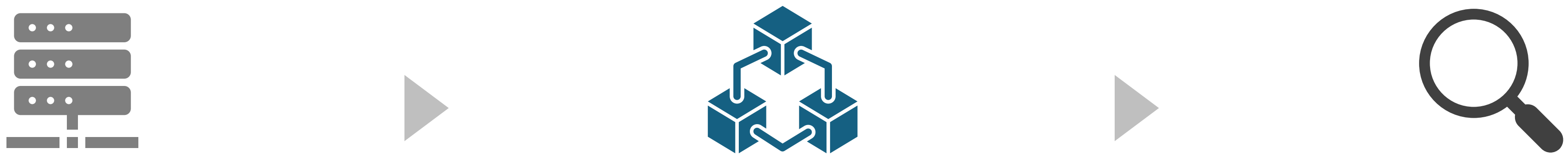
What is the goal of this project?

We are testing the explanatory value of the **CAPM** and **Fama French 3-Factor (FF3F)** models.

- How much portfolio variation do they explain?
- What factors are significant?
- Are there systemic returns unexplained by the model?

These models create the framework for evaluating expected returns

Methodology



Data Acquisition **Models** **Analyze Results**

Data Acquisition

Data Sources

Ken French Data Library

25 Portfolios Formed on Size and Book-To-Market
- Monthly and Equal Weighted

F-F Research Data Factors
- Monthly

Transformations

- **Clean dates:** YYYYMM → Period('M') (monthly index)
- **Null policy:** Drop empty cols; require factors present; remove NA months
- **Model choice:** CAPM or FF3 → select needed columns
- **Windowing:** Parse user start/end month → **clip to coverage**
- **Excess returns:** Compute RE = R− RF

Data Output

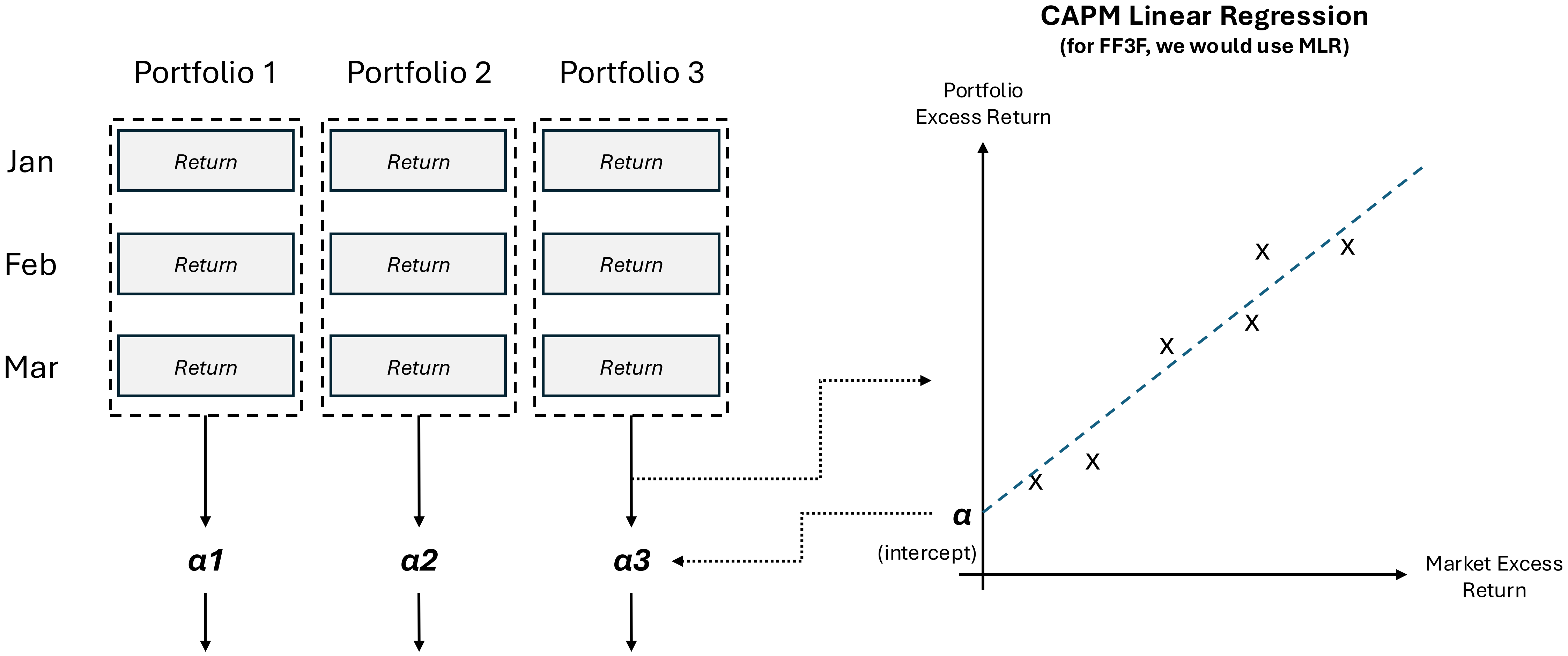
Equal Weighted 25 Portfolios

Factors in CAPM, FF3F, or Both

25 Portfolios – Excess Returns

Model Explanation – Time Series

Goal: Measure risk exposure and test for mispricing



Find t-stat and p-value for each to see if significant

PROBLEM: ANY ONE THESE COULD BE FALSE POSITIVES DUE TO CHANCE

Model Explanation – F-GRS

Goal: Test if the model fully explains all portfolio returns

Solution: we test the alphas to see if they are jointly zero

First, we create a vector of the alphas

$$\begin{bmatrix} \alpha 1 \\ \alpha 2 \\ \alpha 3 \end{bmatrix}$$

Then, we find the GRS statistic and compare it to an F-Distribution to get p-value

Term 1
(sample size adjustment)

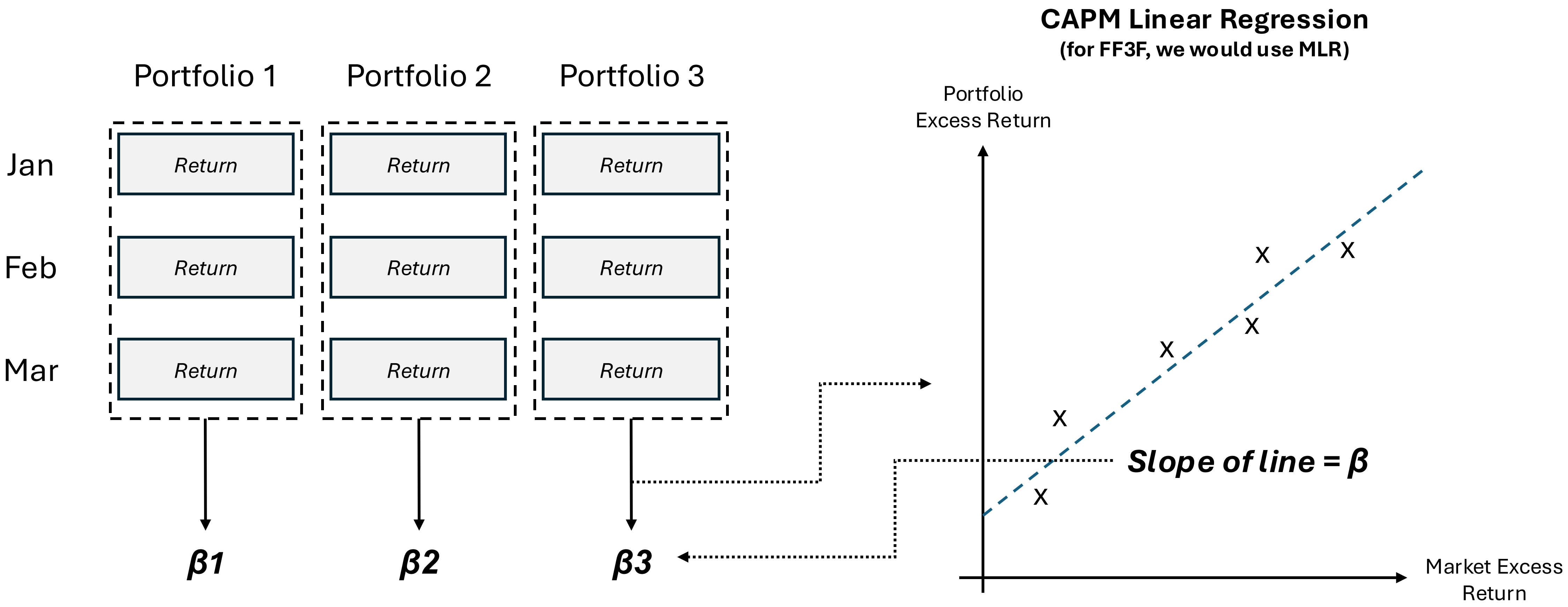
Term 2
(how big are the alphas jointly)

Term 3
(how good are the factors at explaining the returns)

$$\text{GRS} = \frac{\boxed{\dfrac{T}{N} \times \dfrac{T\text{-}N\text{-}K}{T\text{-}K\text{-}1}} \times \boxed{\alpha' \text{ x (inverse residual covariance matrix of } \alpha) \text{ x } \alpha}}{\boxed{1 + \text{factormeans' x (inverse covariance matrix of factorsmeans) x factormeans}}}$$

Model Explanation – Fama-Macbeth

Goal: Measure the market price of each risk factor



Note: These are just estimates because we used a regression, we will need to correct these later

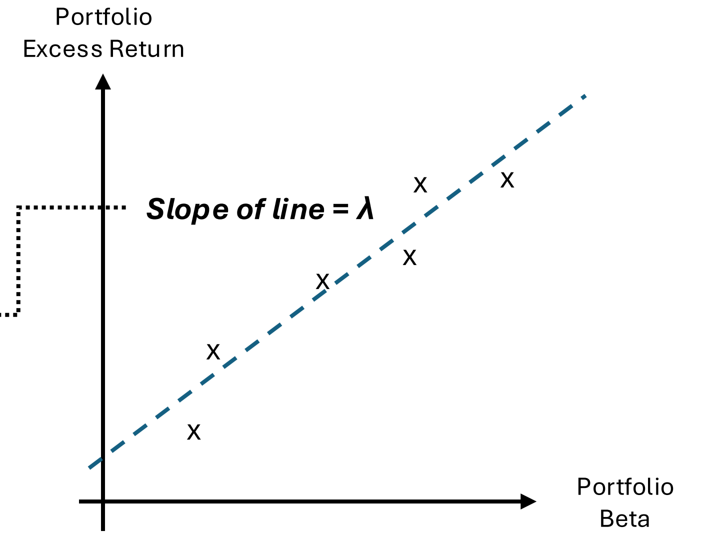
Model Explanation – Fama-Macbeth

Goal: Measure the market price of each risk factor

	Portfolio 1	Portfolio 2	Portfolio 3		
Jan	*Return*	*Return*	*Return*	→	**$\lambda 1$**
Feb	*Return*	*Return*	*Return*	→	**$\lambda 2$**
Mar	*Return*	*Return*	*Return*	→	**$\lambda 3$**

Plugging in betas from last step

Cross-Sectional Regression



Avg(λ) : **Avg(λ)**

SE(λ) : **SE(λ)**

Needed to correct for estimating β earlier → *Shanken SE(λ) :* **SE(λ) x Shanken**

High t(λ): factor is priced in, investors compensated for risk → *t(λ) :* **Avg λ / Shanken SE(λ)**

What does λ mean?

- **What It Is:** the price of risk, i.e. the extra return you get per unit of exposure
- **Example**: If λ = 1%, then taking on 1.0 more beta (risk) gives you 1% higher monthly return

Results – Portfolio Returns

Portfolio	Mean Return (%)	Std Dev (%)	Sharpe Ratio
SMALL LoBM	0.76187298	8.679299387	0.06381482
ME1 BM2	1.183836364	7.274937403	0.134136043
ME1 BM3	1.328001768	6.229361426	0.179793183
ME1 BM4	1.421981818	5.646716336	0.214988091
SMALL HiBM	1.757510354	6.150857298	0.251916965
ME2 BM1	1.045318939	7.626443628	0.109790871
ME2 BM2	1.26835	6.198085974	0.171076193
ME2 BM3	1.348410859	5.676440426	0.200901573
ME2 BM4	1.273561869	5.546917587	0.192098909
ME2 BM5	1.387983081	6.937846934	0.170078418
ME3 BM1	1.064661364	7.032370784	0.121816147
ME3 BM2	1.362433586	5.614191056	0.20562687
ME3 BM3	1.246736364	5.312434974	0.195528288
ME3 BM4	1.310865909	5.610058709	0.196586331
ME3 BM5	1.475649495	6.618769654	0.191522671
ME4 BM1	1.205624495	6.037384096	0.165240347
ME4 BM2	1.249131566	5.184450028	0.200817157
ME4 BM3	1.247761869	5.304364602	0.196019108
ME4 BM4	1.309143434	5.421049801	0.203122721
ME4 BM5	1.278582323	6.523457748	0.164111935
BIG LoBM	1.135980808	5.096717897	0.182073204
ME5 BM2	1.198554545	4.593646058	0.215634701
ME5 BM3	1.228945202	4.646040324	0.219744143
ME5 BM4	1.10317803	5.190817909	0.172453165
BIG HiBM	1.234131818	6.119465784	0.16768241

CAPM

Average Alpha: 0.29
Lambda: 0.91
Average R^2: 0.70

Fama French

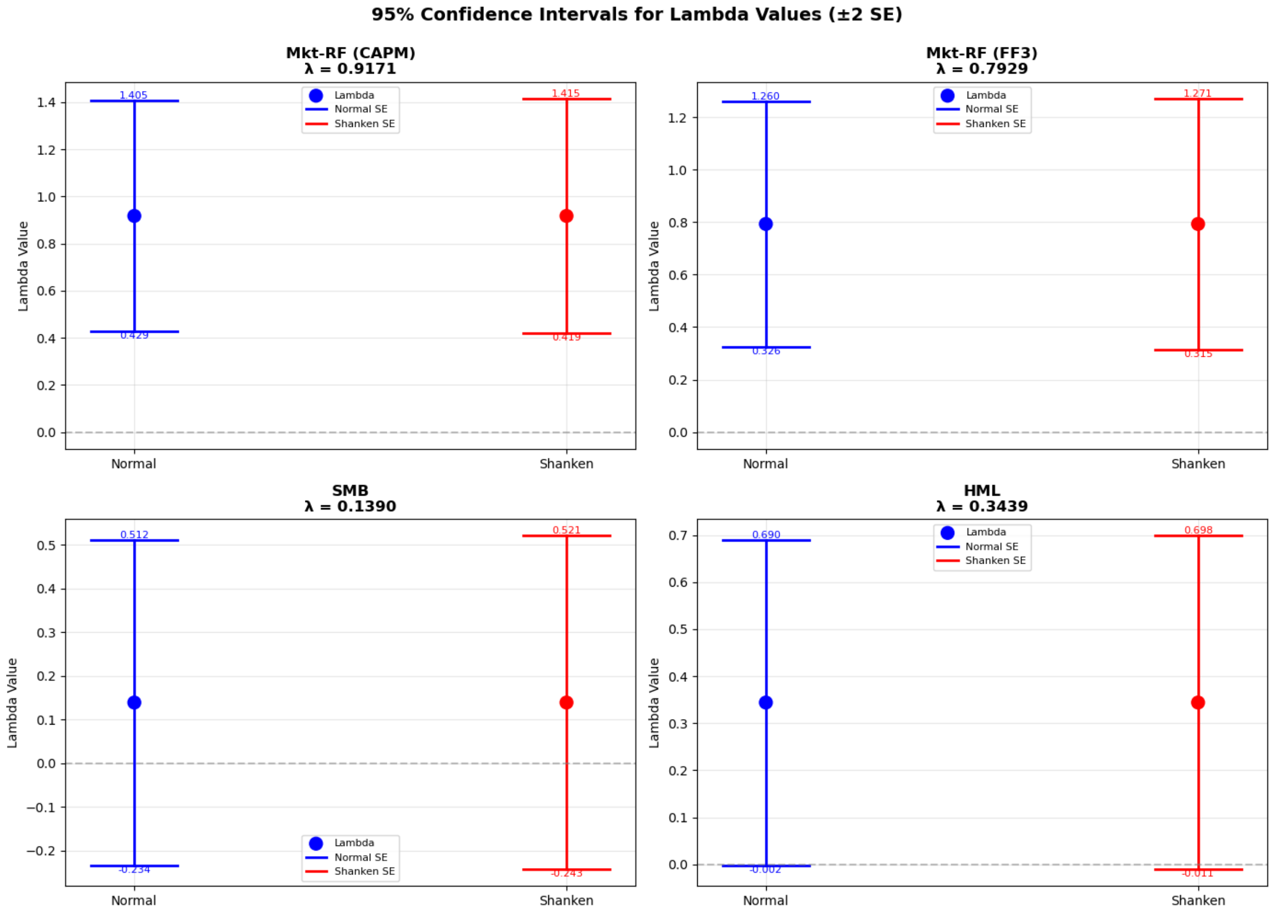
Average Alpha: 0.21
Lambdas
- Market: 0.79
- Small – Big: 0.13
- High – Low BM: 0.34

Average R^2 :0.94

Key Takeaways

- Fama French explains more of the variance in portfolio returns, but seems to maintain a non-zero alpha
- The market factor has the highest affect-per unit of beta on a portfolio's return

Factor Significance

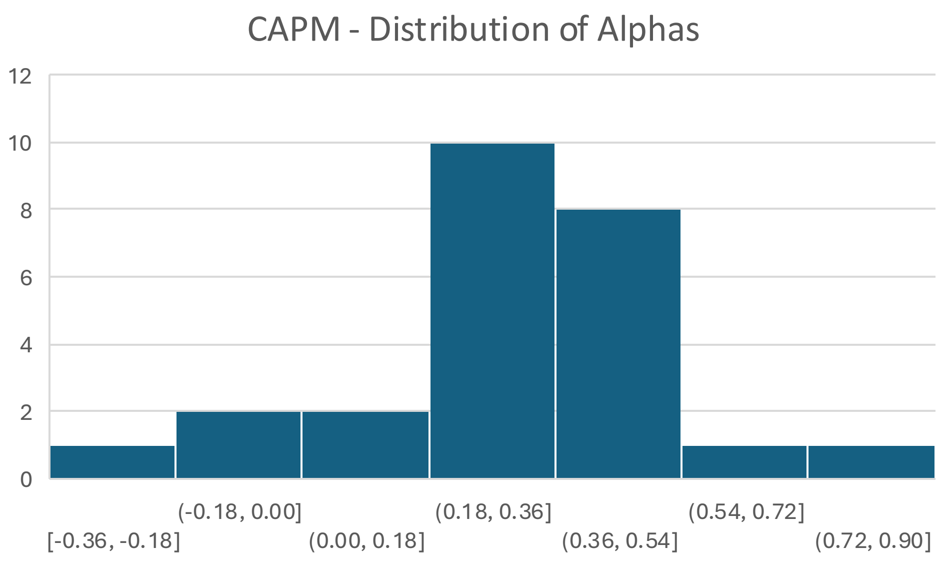


Key Takeaways

- The Market RF is the only significant factor, with the HML being right outside of the confidence interval for statistical significance
- The Shanken corrected confidence intervals are slightly larger

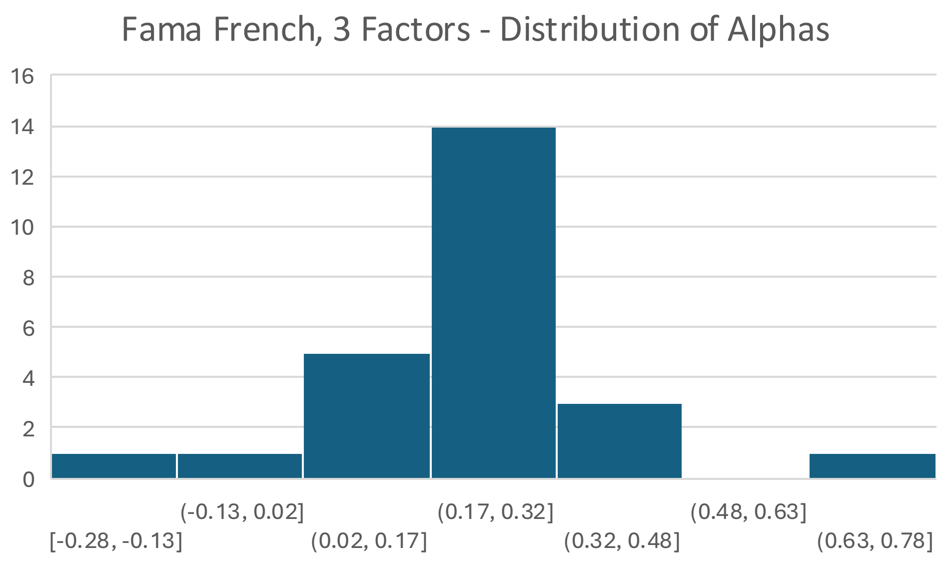
Results – Alphas

CAPM



F statistic: 5.11
P Value: 3.6 E-13
Conclusion: Model does not explain all returns

Fama French



F statistic: 5.39
P Value: 4.3 E-14
Conclusion: Model does not explain all returns

Key Takeaways

- Both CAPM and Fama French models have statistically significant positive returns not explained by the model