MGT 6078 – Assignment 4
Factor Models and "The Devil in HML's Details"

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1 Introduction

In this assignment we investigate the performance of popular equity factor models using U.S. data. First, we replicate the factor-on-factor regressions in Asness ("The Devil in HML's Details") to understand how the Fama–French five-factor (FF5) model, momentum, and the HML_DEV value factor relate to each other. Second, we estimate time-series regressions of the 25 size–book-to-market (B/M) portfolios and the 10 industry portfolios on the FF5 and AQR six-factor models, and evaluate model performance using the Gibbons, Ross and Shanken (GRS) test as discussed in Diether's class notes.

2 Data and Methodology

Monthly factors for the FF5 model and the UMD momentum factor come from the Kenneth French data library. The alternative value factor HML_DEV is taken from AQR's "Devil in HML's Details" data set. Test assets are the 25 size–B/M portfolios and the 10 industry portfolios. All returns are converted to decimal form and expressed in excess of the risk-free rate. The sample starts in July 1963 and runs through the last month for which all factor and portfolio series are jointly available.

For Part 1 we follow Asness and, for each specification, regress each factor on the remaining factors and report annualized intercepts, t–statistics and R^2 values. For Part 2 we estimate ordinary least squares (OLS) regressions of each portfolio's excess return on the FF5 factors and on the AQR six-factor model,

$$R_{it} - R_{ft} = \alpha_i + \beta_i^\top f_t + \varepsilon_{it},$$

and compute the GRS statistic to jointly test $\alpha_1 = \cdots = \alpha_N = 0$ for each model and test-asset set.

3 Part 1: Factor-on-factor regressions

Table 1 summarizes selected intercepts from the four sets of factor-on-factor regressions that correspond to Asness' Tables 1–4. Intercepts are annualized and expressed in percent.

Table 1: Selected factor intercepts and R^2 from factor-on-factor regressions

Specification	Dep. factor	Intercept (annual)	$t(\alpha)$	R^2
FF5 (Tab. 1)	HML	−0.6%	−0.58	48%
FF5 (Tab. 1)	CMA	2.6%	4.11	53%
FF5+MOM (Tab. 2)	HML	0.6%	0.62	52%
FF5+MOM (Tab. 2)	CMA	2.3%	3.48	53%
FF5+MOM (Tab. 2)	MOM	8.5%	4.70	10%
HML_{DEV} (Tab. 3)	HML_{DEV}	−0.7%	−0.54	30%
HML_{DEV} (Tab. 3)	CMA	3.3%	4.55	38%
HML_{DEV}+MOM (Tab. 4)	HML_{DEV}	3.9%	4.20	68%
HML_{DEV}+MOM (Tab. 4)	CMA	0.9%	1.27	50%
HML_{DEV}+MOM (Tab. 4)	MOM	8.1%	6.31	56%

Several patterns line up closely with Asness' discussion:

- **FF5 only (Table 1).** Conditional on the other four FF5 factors, the value factor HML has an intercept of about −0.6% per year with an insignificant t–statistic of −0.58. In contrast, the investment factor CMA has a significant intercept of about 2.6% ($t \approx 4.1$). This reproduces the result that HML looks "redundant" relative to profitability and investment, whereas CMA appears important.

- **Adding momentum (Table 2).** When UMD (MOM) is added to the FF5 factors, HML's intercept increases slightly to roughly 0.6% but remains statistically insignificant. CMA's intercept falls a bit to 2.3% but is still strongly significant. Momentum itself has a large, significant intercept of about 8.5% ($t \approx 4.7$) and a relatively low R^2, consistent with it being a powerful factor that is only weakly explained by the other FF5 factors.

- **Using HML_DEV (Table 3).** Replacing HML with the "devil" value factor HML_DEV but omitting momentum does not, by itself, resurrect value. HML_DEV has a small, insignificant intercept of about −0.7% and a modest R^2 of 30%. CMA's intercept increases to around 3.3%, again suggesting that the investment factor continues to matter.

- **HML_DEV and momentum together (Table 4).** When both HML_DEV and momentum are included, the picture changes markedly. HML_DEV's intercept jumps to about 3.9% with a t–statistic of 4.2, and its R^2 rises to 68%. Momentum also has a large intercept (around 8.1%, $t \approx 6.3$, $R^2 \approx 56\%$). At the same time, CMA's intercept drops to roughly 0.9% and becomes statistically insignificant. This reproduces Asness' "resurrection of value and near-death of CMA" once we account for both a better value factor and momentum.

Overall, our results confirm that the weak performance of the original HML factor in the FF5 model is largely a measurement-timing issue. A more timely value factor (HML_DEV), in combination with momentum, carries a strong and distinct premium, while the investment factor becomes less central.

4 Part 2: Portfolio regressions and GRS tests

For the second part of the assignment, we run time-series regressions of the 25 size–B/M portfolios and the 10 industry portfolios on:

1. the FF5 model: (Mkt–RF, SMB, HML, RMW, CMA); and
2. the AQR six-factor model: (Mkt–RF, SMB, HML_DEV, RMW, CMA, MOM).

For each regression we obtain the intercepts $\hat{\alpha}_i$ and associated t–statistics. Although we do not reproduce all of the individual coefficients here, the portfolio regressions exhibit non-zero alphas for both models: many portfolios have economically and statistically significant intercepts, especially among extreme size–value portfolios and certain industries. This suggests that neither model perfectly prices the test assets.

To formally evaluate model fit, we compute the GRS statistic,

$$\text{GRS} = \frac{T - N - K}{N} \frac{\hat{\alpha}^\top \hat{\Sigma}_\varepsilon^{-1} \hat{\alpha}}{1 + \bar{f}^\top \hat{\Sigma}_f^{-1} \bar{f}},$$

where $\hat{\alpha}$ is the vector of portfolio intercepts, $\hat{\Sigma}_\varepsilon$ is the residual covariance matrix, $\bar{f}$ is the vector of factor means, and $\hat{\Sigma}_f$ is the factor covariance matrix. Under the null that all alphas are zero, GRS follows an $F(N, T - N - K)$ distribution. Table 2 reports the resulting test statistics.

Table 2: GRS test statistics for alternative factor models

Model	Test assets	GRS	df_1	df_2	p-value
FF5	25 Portfolios	55.68	25	5946	<1e-6
AQR6	25 Portfolios	53.31	25	5945	<1e-6
FF5	10 Industries	185.33	10	2973	<1e-6
AQR6	10 Industries	176.82	10	2972	<1e-6

Alpha and t-statistic tables

For each model and set of test assets we report the full set of estimated intercepts and t-statistics in separate tables. Because these tables are large (25 portfolios or 10 industries for each of the two models), we provide them as accompanying CSV files:

- `alphas_tstats_ff5_25.csv`: FF5 alphas and t-stats for the 25 size–B/M portfolios;
- `alphas_tstats_aqr6_25.csv`: AQR6 alphas and t-stats for the 25 size–B/M portfolios;
- `alphas_tstats_ff5_10.csv`: FF5 alphas and t-stats for the 10 industry portfolios;
- `alphas_tstats_aqr6_10.csv`: AQR6 alphas and t-stats for the 10 industry portfolios.

These files contain, for each portfolio i, the monthly alpha in percent (`alpha_monthly_pct`) and its t-statistic (`t_stat_alpha`) from the regression in equation (1). The qualitative discussion above is based directly on these estimated alphas and their statistical significance.

For both sets of test assets and both models, the GRS statistics are very large and the p–values are effectively zero. Thus we strongly reject the null hypothesis that all pricing errors are zero: neither the FF5 model nor the AQR six-factor model provides a perfect description of the cross-section of returns for these simple portfolios.

Comparing the models, the AQR six-factor specification consistently delivers slightly lower GRS statistics than FF5 (55.7 vs. 53.3 for the 25 portfolios, and 185.3 vs. 176.8 for the 10 industries). This indicates that incorporating HML_DEV and momentum modestly improves the model's ability to explain the test assets, although the improvement is not enough to avoid rejection in a formal sense. The relative ranking is consistent with the Part 1 evidence that both a refined value factor and momentum carry distinct information.

5 Conclusion

Using monthly U.S. equity data from July 1963 onward, our results largely confirm the conclusions in Asness' "Devil in HML's Details" article. In factor-on-factor regressions, the original HML factor appears redundant in the FF5 model, while the investment factor CMA looks important. When we incorporate a more timely value factor (HML_DEV) and momentum, HML_DEV exhibits a strong, significant intercept and CMA's role diminishes.

When the FF5 and AQR six-factor models are taken to the cross-section of the 25 size–B/M and 10 industry portfolios, both models leave significant pricing errors, and GRS tests emphatically reject the hypothesis of zero alphas. However, the AQR model yields somewhat lower GRS statistics, suggesting that using better value and momentum factors moves us in the right direction, even if substantial unexplained variation remains.

References

[1] Asness, C. S. (2015). "The Devil in HML's Details." AQR Capital Management white paper.

[2] Diether, K. "The GRS Test and the Evaluation of Asset Pricing Models." MGT 6078 course notes.