

# Empirical Finance

## Homework 3

Jiyan Jonas Schneider (82441028)

jiyan.schneider@keio.jp

Graduate School of Economics

Problem 1) Evaluate the performance of the Capital Asset Pricing Model (CAPM).

The CAPM results using python for my analysis for the Gibbons-Ross-Shanken test and the Fama-MacBeth procedure are like this.

```
>>>
--- CAPM Results for 1963-07 to 1991-12 ---
1) Gibbons-Ross-Shanken (GRS) Test
   Periods (T): 342, Assets (N): 25, Factors (K): 1
   GRS Statistic: 2.0171
   Distribution: F(25, 316)
   p-value: 0.0033

2) Fama-MacBeth Procedure (Standard)
      Mean Premium Std. Error t-statistic p-value Num Obs
Intercept      0.0090%    0.0039%         2.29  0.0228     342
mktrf          -0.0024%    0.0047%        -0.50  0.6167     342

Comparison: Mean Premia vs. Mean Factors
- mktrf: Premium=-0.0024%, Factor Mean=0.0041%
-----
```

Figure 1: CAPM results for the 1963-07 to 1991-12 period.

We can interpret these results as following.

### 1. Gibbons-Ross-Shanken (GRS) Test:

- The GRS statistic is 2.0171 with a **p-value of 0.0033**.
- The null hypothesis of the GRS test is that the alphas (pricing errors) of all 25 portfolios are jointly zero.
- Since the p-value is less than 0.05, we **strongly reject the null hypothesis**. This is strong evidence that the CAPM fails to explain the returns of the 25 portfolios.

### 2. Fama-MacBeth Procedure:

- **Market Premium (mktrf):** The estimated risk premium for the market factor is statistically **insignificant** (p-value = 0.6167). The CAPM predicts this should be positive and significant. This is a major failure of the model.
- **Intercept (Alpha):** The average intercept from the cross-sectional regressions is positive and **statistically significant** (p-value = 0.0228). A good asset pricing model should have an intercept of zero. A significant intercept indicates systematic mispricing that the model cannot explain.

Thus both tests reject the CAPM, and we have to conclude that the model does not sufficiently explain the cross-section of stock returns in this period.

Problem 2) Evaluate the performance of the Fama-French 3-Factor (FF3) Model and compare it to the CAPM.

```

--- Fama-French 3-Factor Results for 1963-07 to 1991-12 ---
1) Gibbons-Ross-Shanken (GRS) Test
   Periods (T): 342, Assets (N): 25, Factors (K): 3
   GRS Statistic: 1.4581
   Distribution: F(25, 314)
   p-value: 0.0758

2) Fama-MacBeth Procedure (Standard)
   Mean Premium Std. Error t-statistic p-value Num Obs
Intercept      0.0060%    0.0036%      1.65  0.1004    342
mktrf         -0.0016%    0.0044%     -0.35  0.7250    342
smb            0.0020%    0.0016%      1.27  0.2042    342
hml            0.0043%    0.0014%      3.03  0.0026    342

Comparison: Mean Premia vs. Mean Factors
- mktrf: Premium=-0.0016%, Factor Mean=0.0041%
- smb: Premium=0.0020%, Factor Mean=0.0026%
- hml: Premium=0.0043%, Factor Mean=0.0038%
-----

```

Figure 2: FF3 results for the 1963-07 to 1991-12 period.

Overall, the Fama-French 3-Factor model performs significantly better than the CAPM and we can't reject it based on our data.

### 1. Gibbons-Ross-Shanken (GRS) Test:

- The GRS statistic is 1.4581 with a **p-value of 0.0758**.
- Since this p-value is greater than 0.05, we **fail to reject the null hypothesis**.
- This means that means that adding the size (SMB) and value (HML) factors explains the pricing errors that were present in the CAPM and that the FF3 model is better in describing Asset returns than the CAPM.

### 2. Fama-MacBeth Procedure:

- **Value Premium (hml):** The estimated risk premium for the value factor is 0.43% per month and is **highly statistically significant** (t-stat = 3.03, p-value = 0.0026). This indicates that value is a priced risk factor.
- **Size Premium (smb):** The size premium is positive but not statistically significant.
- **Intercept (Alpha):** The intercept is now **statistically insignificant** (p-value = 0.1004). This is another sign of a well-specified model, as it shows that the three factors account for the returns, leaving no significant unexplained portion.

Thus we can see that the FF3 model is not rejected by the GRS test, and also produces a non-significant alpha. Furthermore it identifies the value factor (HML) as a significant source of priced risk in the cross-section of stock returns.

Problem 3) Discuss the effect of using different standard error corrections (Newey-West, Shanken).

- **Newey-West:** The Newey-West correction accounts for autocorrelation in the lambda time series. For both models, this correction slightly **increases** the standard errors and thus **lowers** the t-statistics. For example, in the FF3 model, the t-statistic for HML drops from 3.03 to 2.59, but remains highly statically significant. This suggests some autocorrelation is present, but it does not change the main conclusions.
- **Shanken Correction:** The Shanken correction accounts for the fact that the betas used in the second pass are estimated with error. This correction also slightly **increases** the standard errors. For

example, the t-statistic for HML in the FF3 model drops from 3.03 to 2.96. Again, the change is minor and does not alter the conclusion that HML is a priced factor.

These are the results for if we do the corrections for the CAPM for the first period (1963-1991)

```

2) Fama-MacBeth Procedure (Newey-West, lags=5)
      Mean Premium Std. Error t-statistic p-value Num Obs
Intercept    0.0090%    0.0046%      1.95  0.0514    342
mktrf        -0.0024%    0.0058%     -0.41  0.6820    342

Comparison: Mean Premia vs. Mean Factors
- mktrf: Premium=-0.0024%, Factor Mean=0.0041%
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2) Fama-MacBeth Procedure (Shanken Correction)
      Mean Premium Std. Error t-statistic p-value Num Obs
Intercept    0.0090%    0.0040%      2.28  0.0233    342
mktrf        -0.0024%    0.0047%     -0.50  0.6181    342

Comparison: Mean Premia vs. Mean Factors
- mktrf: Premium=-0.0024%, Factor Mean=0.0041%
-----

```

Figure 3: Corrected standard errors for CAPM, first period.

and these are the results when doing the corrections for the FF3 model in the same period.

```

2) Fama-MacBeth Procedure (Newey-West, lags=5)
      Mean Premium Std. Error t-statistic p-value Num Obs
Intercept    0.0060%    0.0038%      1.59  0.1120    342
mktrf        -0.0016%    0.0040%     -0.39  0.6954    342
smb          0.0020%    0.0019%      1.06  0.2883    342
hml          0.0043%    0.0016%      2.59  0.0096    342

Comparison: Mean Premia vs. Mean Factors
- mktrf: Premium=-0.0016%, Factor Mean=0.0041%
- smb: Premium=0.0020%, Factor Mean=0.0026%
- hml: Premium=0.0043%, Factor Mean=0.0038%
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2) Fama-MacBeth Procedure (Shanken Correction)
      Mean Premium Std. Error t-statistic p-value Num Obs
Intercept    0.0060%    0.0037%      1.61  0.1087    342
mktrf        -0.0016%    0.0045%     -0.34  0.7313    342
smb          0.0020%    0.0016%      1.24  0.2150    342
hml          0.0043%    0.0014%      2.96  0.0033    342

Comparison: Mean Premia vs. Mean Factors
- mktrf: Premium=-0.0016%, Factor Mean=0.0041%
- smb: Premium=0.0020%, Factor Mean=0.0026%
- hml: Premium=0.0043%, Factor Mean=0.0038%
-----

```

Figure 4: Corrected standard errors for FF3, first period.

Repeating the earlier point, we can see that although the standard errors (and thus p-values and t-statistics) change, they do not influence the results we found in the previous two questions.

Problem 4) How do the models perform over the full sample period?

Over the full sample we find that both models perform poorly especially according to the GRS test These are the results for the CAPM over the full sample.  
And here are the results for FF3 model over the full sample.

```

--- CAPM Results for 1927-01 to 2024-12 ---
1) Gibbons-Ross-Shanken (GRS) Test
  Periods (T): 1176, Assets (N): 25, Factors (K): 1
  GRS Statistic: 3.4255
  Distribution: F(25, 1150)
  p-value: 0.0000

2) Fama-MacBeth Procedure (Standard)
      Mean Premium Std. Error t-statistic p-value Num Obs
Intercept    0.0039%    0.0033%         1.18  0.2365    1176
mktrf        0.0041%    0.0035%         1.16  0.2460    1176

  Comparison: Mean Premia vs. Mean Factors
  - mktrf: Premium=0.0041%, Factor Mean=0.0068%
-----

```

Figure 5: Results for the CAPM model, full sample.

```

--- Fama-French 3-Factor Results for 1927-01 to 2024-12 ---
1) Gibbons-Ross-Shanken (GRS) Test
  Periods (T): 1176, Assets (N): 25, Factors (K): 3
  GRS Statistic: 3.3910
  Distribution: F(25, 1148)
  p-value: 0.0000

2) Fama-MacBeth Procedure (Standard)
      Mean Premium Std. Error t-statistic p-value Num Obs
Intercept    0.0173%    0.0040%         4.30  0.0000    1176
mktrf        -0.0100%    0.0042%        -2.39  0.0170    1176
smb          0.0011%    0.0010%         1.08  0.2782    1176
hml          0.0037%    0.0011%         3.44  0.0006    1176

  Comparison: Mean Premia vs. Mean Factors
  - mktrf: Premium=-0.0100%, Factor Mean=0.0068%
  - smb: Premium=0.0011%, Factor Mean=0.0018%
  - hml: Premium=0.0037%, Factor Mean=0.0035%
-----

```

Figure 6: Results for the FF3 model, full sample.

We can see that the CAPM is still performing poorly with both procedures. Furthermore we see that the FF3 model also starts to falter. The intercept is now statistically significant. SMB stayed statistically insignificant. HML did stay statistically significant, which is good, but `mktrf`, the market factor, actually switched signs.

I also conducted the Newey-West procedure and the Shanken Correction to see what would happen, because I thought it might make the `mktrf` coefficient at least be insignificant, however even with the adjusted standard errors, the results don't change.

```

2) Fama-MacBeth Procedure (Newey-West, lags=6)
      Mean Premium Std. Error t-statistic p-value Num Obs
Intercept    0.0173%    0.0037%      4.65  0.0000    1176
mktrf       -0.0100%    0.0038%     -2.62  0.0089    1176
smb          0.0011%    0.0010%      1.08  0.2812    1176
hml          0.0037%    0.0012%      3.05  0.0023    1176

Comparison: Mean Premia vs. Mean Factors
- mktrf: Premium=-0.0100%, Factor Mean=0.0068%
- smb: Premium=0.0011%, Factor Mean=0.0018%
- hml: Premium=0.0037%, Factor Mean=0.0035%
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2) Fama-MacBeth Procedure (Shanken Correction)
      Mean Premium Std. Error t-statistic p-value Num Obs
Intercept    0.0173%    0.0041%      4.25  0.0000    1176
mktrf       -0.0100%    0.0042%     -2.37  0.0182    1176
smb          0.0011%    0.0010%      1.07  0.2832    1176
hml          0.0037%    0.0011%      3.40  0.0007    1176

Comparison: Mean Premia vs. Mean Factors
- mktrf: Premium=-0.0100%, Factor Mean=0.0068%
- smb: Premium=0.0011%, Factor Mean=0.0018%
- hml: Premium=0.0037%, Factor Mean=0.0035%
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```

Figure 7: Corrected standard errors full period for FF3.