

# Mgmt 237e: Homework 6

## Estimating Linear Factor Models

Drew Creal  
TA: Patrick Kiefer

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This homework assignment combines lecture #8 and #9. You can use Matlab or R. It is due on Thursday March 10 at 9:00 AM. Question #2 is optional. Notice that one major difference between the regressions in Question #1 and Question #2 is that the factors in Question #1 are traded assets whereas in Question #2 they are macro variables.

1. **Fama and French (1993) model:** Download the 48 industry portfolio data (monthly) from Kenneth French's web site. Use the data from 1960 through 2015.<sup>1</sup> Use the value-weighted returns. You may drop the industries that have missing values and are reported as -99.99. Also, download the 3 Fama-French factors from his web site. Use the monthly risk-free rate series provided by French to compute excess returns on these 48 portfolios.
  - (a) Can we use time-series regressions on excess returns to test the Fama-French model on these 48 industry portfolios? Explain.
  - (b) If the answer is yes, use the results from the time series regression to test the null hypothesis that the pricing errors are zero.
  - (c) If not, devise another estimation procedure.
  - (d) Is the variation in industry portfolio returns harder to explain than the variation in the 25 portfolios sorted by B/M ratios and size discussed in class? Explain your answers.
2. **Chen, Roll, and Ross (1986) model (Optional):** Chen, Roll, and Ross (1986) model equity returns as a function of macro-economic variables. The CRR factors are in the spreadsheet. The CRR multi-factor model for monthly returns is given by:

$$R_{it}^e = a_i + b_{i,MP}MP_t + b_{i,DEI}DEI_t + b_{i,UI}UI_t + b_{i,UPR}^iUPR_t + b_{i,UTS}UTS_t + \varepsilon_{it}.$$

We use  $\lambda_j$  to denote the risk price of factor  $f_{jt}$ . The expected returns on asset  $i$  are given by:

$$E[R_{it}^e] = \lambda_0 + b_{i,MP}\lambda_{MP} + b_{i,DEI}\lambda_{DEI} + b_{i,UI}\lambda_{UI} + b_{i,UPR}\lambda_{UPR} + b_{i,UTS}\lambda_{UTS}.$$

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<sup>1</sup>Of course, you can always try earlier periods to check the robustness of the results.

Table 1: Macroeconomic Factors

|          |  |   |
|----------|--|---|
| I        | <i>Inflation</i>                             | <i>Monthly rate of change in percentages, CRSP</i>      |
| TB       | <i>Treasury Bill Return</i>                  | <i>Monthly rate of return on one-month Tbills, CRSP</i> |
| LGB      | <i>Long Term Government Bond</i>             | <i>Rate of return on long-term government bonds</i>     |
| IP       | <i>Industrial production</i>                 | <i>Federal Reserve Statistical Release, G.17</i>        |
| BAA      | <i>Low-grade bonds</i>                       | <i>Rate of Return on low-grade bonds</i>                |
| $MP(t)$  | <i>Monthly growth, industrial production</i> | $\log IP(t) - \log IP(t-1)$                             |
| $UI(t)$  | <i>Unexpected Inflation</i>                  | $I_t - I_{t-1}$   |
| $DEI(t)$ | <i>Change in Expected Inflation</i>          | $I_{t-1} - I_{t-2}$                                     |
| $URP(t)$ | <i>Risk premium</i>                          | $Baa(t) - LGB(t)$                                       |
| $UTS(t)$ | <i>Term Structure</i>                        | $LGB(t) - TB(t)$  |

Notes:

- (a) Can we use time-series regressions on excess returns to test the CRR model on the same 48 industry Fama-French portfolios? Explain.
- (b) If the answer is yes, use the results from the time series regression to test the null hypothesis that the pricing errors are zero. End the sample in 12/2008.
- (c) If the answer is no, implement another procedure on these 48 portfolios. Report the results.
  - i. Test the null that the pricing errors are zero.
  - ii. Interpret the CRR risk prices.
  - iii. Does the CRR model explain more of the cross-sectional variation in average excess returns than the Fama and French (1993) 3-factor model?

## References

- Chen, N.-F., R. Roll, and S. A. Ross (1986). Economic forces and the stock market. *The Journal of Business* 59(3), pp. 383–403.
- Fama, E. F. and K. French (1993). Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics* 33(1), 23–49.