# Portfolio Management - Applications
# Exercise: Factor Pricing

Date due: December 5, 2018

**Factor Models:** In this exercise you will estimate risk premia in multi-factor models. Discuss if value is redundant. Use the procedure proposed by Fama and MacBeth (1973) and outlined in the course slides.

**Data:** We provide data from original sources Ken French's data library and AQR. The data set consists of 100 portfolios sorted on size and book-to-market, long-short factor portfolios from Ken French's website (market excess return, SMB, HML, CMA, and RWA), long-short factor portfolios from the AQR website (HML-DEV and UMD, aggregated from daily to monthly frequency), and the return on the risk-free asseet, again from K. French.

**Details:** Run the Fama-MacBeth procedure to estimate the risk premia of the following multi-factor models:

1. The Fama-French 5 factor model
2. A version without HML
3. A version where HML from Fama-French is replaced with HML-DEV.

The following explanation refers to the FF 5-factor model:
In the first step, for each portfolio $i$ estimate the time series regression

$$r_{i,t} = \alpha_i + \beta_{i,M} r_{M,t} + \beta_{i,SMB} r_{SMB,t} + \beta_{i,HML} r_{HML,t} +$$

$$+ \beta_{i,RMW} r_{RMW,t} + \beta_{i,CMA} r_{CMA,t} + \epsilon_{i,t}.$$

The variable $r_{i,t}$ denotes the excess return of portfolio $i$ in period $t$, $r_{M,t}$ the excess return of the market, and $r_{SMB,t}$, $r_{HML,t}$, $r_{RMW,t}$ , $r_{CMA,t}$ are the size, value, profitability, and investment factors, respectively.

In the second step use the estimated $\hat{\beta}_{i,F}$ in cross-sectional regressions

$$r_{i,t} = a_i + \hat{\beta}_{i,M,\tau} \gamma_{M,t} + \cdots + \hat{\beta}_{i,CMA,\tau} \gamma_{CMA,t} + e_{i,t}$$

to obtain the estimates for realized factor risk premia $\gamma_{F,t}$ for each time $t$. For each factor, compute the average risk premium, its standard error, and provide an approximate 95% confidence interval. Estimate versions with and without $a_i$. How well are the models able to explain cross-sectional asset prices?

Discuss if value is redundant. To do so, you can compare the various models you have stimated. In addition, you can try to explain the value factor in a time series regression

$$r_{HML,t} = \alpha + \beta_M r_{M,t} + \beta_{SMB} r_{SMB,t} + \beta_{RMW} r_{RMW,t} + \beta_{CMA} r_{CMA,t} + \epsilon_t$$

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Important: Interpret your results. As background readings, use Eugene F. Fama and Kenneth R. French (1992), The Journal of Finance, Vol. 47(2), pp. 427–465 and Asness, Cliff S., Frazzini, Andrea, Israel, Ronen and Moskowitz, Tobias J., Fact, Fiction, and Value Investing (2015), Journal of Portfolio Management, Fall 2015, Vol. 42.