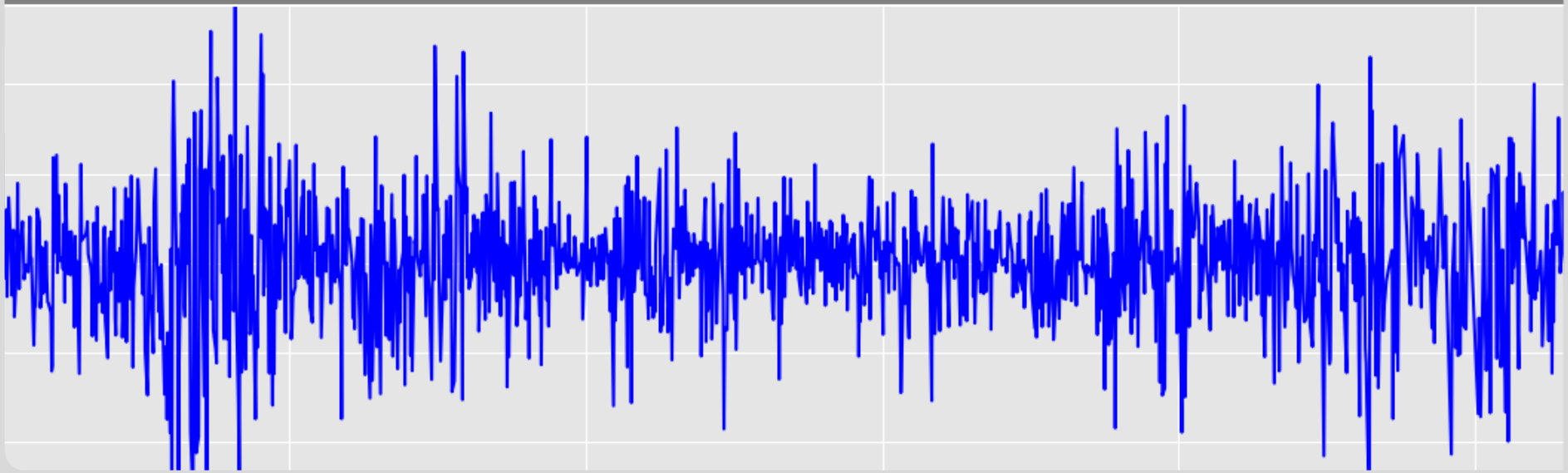
Karlsruher Institut für Technologie

Problem Set 3
Linear Factor Models and Equity Risk Premium

Solution submitted by Thi Ha Giang Vo and Lotta Rüter
CRAM-Programming Lab WS 2017/18

FBV, Chair of Financial Economics and Risk Management



Question 1a: Test Assets and Factor Returns

- ***Market return:*** return on a region's value-weight market portfolio minus the German one month T-bill rate
- ***SMB*** *(Small Minus Big):* average return on three small portfolios minus the average return on three big portfolios)
  = 1/3 (Small Value + Small Neutral + Small Growth)
  - 1/3 (Big Value + Big Neutral + Big Growth)
- ***HML:*** (High Minus Low): average return on two value portfolios minus the average return on two growth portfolios
  = 1/2 (Small Value + Big Value)
  - 1/2 (Small Growth + Big Growth)
- ***WML:*** equal-weight average of the returns for the two winner portfolios for a region minus the average of the returns for the two loser portfolios
  = 1/2 (Small High + Big High)
  - 1/2 (Small Low + Big Low)

For more information see http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/f-f_developed.html

Question 1a: Test Assets and Factor Returns

- Factors are created by finding subsets of equity, debt and volatility securities that have higher payoffs than the respective broad index and show common characteristics (e.g. illiquidity, high default risk, …)
- Pension fund can invest in these factors by building long and short positions in the respective underlyings

Question 1b: Capital Asset Pricing Model (CAPM)

	Asset 11	Asset 44
Alpha (T-statistic)	0.0012 (0.012)	0.1216 (0.737)
Beta (T-Statistic)	0.3274 (16.707)	0.9134 (28.299)
R^2	0.312	0.565
Return forecasts	1.96	5.48

Summary of statistics of asset 11 and asset 44 using the CAPM

Question 1c: Fama MacBeth Methodology

- The Market price of risk for investing into equity is lambda.
  - ***Example***
    Earnings volatility, unexpected financial performance, pricing changes, and bad management are common factors in price risk. For example, assume that Company XYZ is trading at $5 per share. The company is stable and doing well, but there is some uncertainty in the market about Company XYZ's new model of widget that it coming out next year, and the economy looks like it's headed for a recession. There is no certainty that the price of Company XYZ will stay at $5 per share or rise above $5, and thus investors in Company XYZ bear price risk when they hold the stock.

Question 1c: Fama MacBeth Methodology

- The method estimates the betas and risk premia including any risk factors that are expected to have an effect on the asset prices. The method works with multiple assets across time. The parameters are estimated in two steps:
  - Determine the **asset‘s beta** for each risk factor:
    Regress each asset on the proposed risk factors
  - Determine **risk premium** for each factor:
    Regress all asset returns for a fixed time period on the estimated betas.

Question 1d: ‘Class ERP‘

- *See code…*

Question 1e: Estimate ERP

	Equity Risk Premium
Alpha	0.48
MRP	-0.19 (-0.72)

- *Alpha*
  - Is the intercept of the security characteristic line (SCL), that is, the coefficient of the constant in a market model regression. In the result, alpha = 0.48 > 0 , so the investment has a return in excess of the reward for the assumed risk.
- *MRP*
  - A negative Market Risk Premium means the investor has to pay to take on risk. You could argue that other risks are taken into account such as (e.g. ownership, fees, compliance,…) that make it safer to have that money invested in the German market so your overall risk is reduced and you earn a net positive prime of risk and cash

Question 1f: Fama French 3 Factor Model

	Asset 11	Asset 44
Alpha (T-statistic)	0.08 (0.87)	-0.04 (-0.28)
Beta (T-Statistic)	0.48 (23.63)	1.16 (36.63)
B_SMB (T-Statistic)	0.46 (13.66)	0.79 (14.99)
B_HML (T-Statistic)	-0.09 (-2.95)	0.40 (8.47)
R^2	0.48	0.70

Summary of statistics of asset 11 and asset 44
using the Fama French 3 Factor Model

Question 1f: Fama French 3 Factor Model

- Economic idea behind the additional factor SMB and 'HML‘
  - SMB accounts for the spread in returns between small- and large-sized firms, which is based on the company's market capitalization. It resembles the observation that small firms tend to pay higher return than large firms.
  - HML accounts for the spread in returns between value and growth stocks and argues that companies with high book-to-market ratios, also known as value stocks, outperform those with lower book-to-market values, known as growth stocks.

Question 1f: Fama French 3 Factor Model

- This extended model provides a better description of asset returns
  - Used to evaluate profit margins for a security over the short- and long-term, the HML provides an indication of the anticipated performance of the security in the future.
  - Including SMB, the model attempt to explain excess returns made by a manager's portfolio. Incorporating SMB shows whether management was relying on the small firm effect (investing in stocks with low market capitalization) to earn an abnormal return.
  - Concerning our data, it explains more of the included variance than the simple model.

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Question 1a: Test Assets and Factor Returns

- *Fo*
  - 1/2 (Small Low + Big Low)

Question 1b: Capital Asset Pricing Model (CAPM)

Asset 11

OLS Regression Results

Dep. Variable:	y	R-squared:	0.312
Model:	OLS	Adj. R-squared:	0.311
Method:	Least Squares	F-statistic:	279.1
Date:	Tue, 07 Nov 2017	Prob (F-statistic):	5.90e-52
Time:	16:29:35	Log-Likelihood:	-1437.7
No. Observations:	618	AIC:	2879.
Df Residuals:	616	BIC:	2888.
Df Model:	1		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	0.0012	0.100	0.012	0.990	-0.195	0.198
0	0.3274	0.020	16.707	0.000	0.289	0.366

Omnibus:	146.144	Durbin-Watson:	1.919
Prob(Omnibus):	0.000	Jarque-Bera (JB):	780.295
Skew:	0.938	Prob(JB):	3.64e-170
Kurtosis:	8.175	Cond. No.	5.13

Warnings:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.

Question 1b: Capital Asset Pricing Model (CAPM)

Asset 44

OLS Regression Results

Dep. Variable:	y	R-squared:	0.565
Model:	OLS	Adj. R-squared:	0.565
Method:	Least Squares	F-statistic:	800.8
Date:	Tue, 07 Nov 2017	Prob (F-statistic):	1.65e-113
Time:	16:31:13	Log-Likelihood:	-1746.0
No. Observations:	618	AIC:	3496.
Df Residuals:	616	BIC:	3505.
Df Model:	1		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	0.1216	0.165	0.737	0.461	-0.202	0.445
0	0.9134	0.032	28.299	0.000	0.850	0.977

Omnibus:	46.229	Durbin-Watson:	1.670
Prob(Omnibus):	0.000	Jarque-Bera (JB):	156.900
Skew:	0.262	Prob(JB):	8.50e-35
Kurtosis:	5.412	Cond. No.	5.13

Warnings:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.

Question 1e: Estimate ERP

Portfolio	Beta
14	1.02
34	0.96
24	0.95
44	0.91
23	0.78
43	0.74
13	0.73
33	0.71

Portfolio	Beta
42	0.59
22	0.58
32	0.54
12	0.48
41	0.44
21	0.37
31	0.36
11	0.33

Question 1f: Fama French 3 Factor Model

Asset 11

OLS Regression Results

Dep. Variable:	y	R-squared:	0.481
Model:	OLS	Adj. R-squared:	0.478
Method:	Least Squares	F-statistic:	189.5
Date:	Tue, 07 Nov 2017	Prob (F-statistic):	5.55e-87
Time:	16:06:30	Log-Likelihood:	-1350.6
No. Observations:	618	AIC:	2709.
Df Residuals:	614	BIC:	2727.
Df Model:	3		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	0.0771	0.089	0.871	0.384	-0.097	0.251
0	0.4787	0.020	23.631	0.000	0.439	0.518
SMB	0.4608	0.034	13.660	0.000	0.395	0.527
HML	-0.0890	0.030	-2.947	0.003	-0.148	-0.030

Omnibus:	201.142	Durbin-Watson:	1.987
Prob(Omnibus):	0.000	Jarque-Bera (JB):	1211.842
Skew:	1.308	Prob(JB):	7.11e-264
Kurtosis:	9.342	Cond. No.	5.57

Question 1f: Fama French 3 Factor Model

Asset 44

OLS Regression Results

Dep. Variable:	y	R-squared:	0.703
Model:	OLS	Adj. R-squared:	0.701
Method:	Least Squares	F-statistic:	484.0
Date:	Tue, 07 Nov 2017	Prob (F-statistic):	2.73e-161
Time:	16:09:08	Log-Likelihood:	-1628.4
No. Observations:	618	AIC:	3265.
Df Residuals:	614	BIC:	3283.
Df Model:	3		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	-0.0382	0.139	-0.275	0.783	-0.311	0.234
0	1.1632	0.032	36.629	0.000	1.101	1.226
SMB	0.7926	0.053	14.988	0.000	0.689	0.896
HML	0.4008	0.047	8.468	0.000	0.308	0.494

Omnibus:	34.481	Durbin-Watson:	1.944
Prob(Omnibus):	0.000	Jarque-Bera (JB):	86.657
Skew:	0.256	Prob(JB):	1.52e-19
Kurtosis:	4.762	Cond. No.	5.57