- Compare the Fama French three factor model to CAPM model :

AXP:

CAPM model	***R^2: 0.4251***	***Adj. R^2: 0.4202***	F-statistic: 87.25	p-value: 7.279e-16
	Coefficients:	estimate	Std. error	t value	p-value
	intercept	-0.0009649	0.0079261	-0.122	0.903
	MKTRF	1.6369379	0.1752438	9.341	7.28e-16
3 factor model	***R^2: 0.4649***	***Adj. R^2: 0.451***	F-statistic: 33.59	p-value: 1.06e-15
	Coefficients:	Estimate	Std. error	t value	p-value
	Intercept	0.0007908	0.0077379	0.102	0.9188
	MKTRF	1.4492480	0.1892319	7.659	6.18e-12
	SMB	0.1068824	0.3531479	***0.303***	0.7627
	HML	0.8324850	0.2894716	***2.876***	0.0048

GE:

CAPM model	***R^2: 0.5483***	***Adj. R^2: 0.5444***	F-statistic: 143.2	p-value: <2.2e-16
	Coefficients:	estimate	Std. error	t value	p-value
	intercept	-0.010878	0.005353	-2.032	0.0444
	MKTRF	1.416312	0.118351	11.967	<2e-16
3 factor model	***R^2: 0.6309***	***Adj. R^2: 0.6213***	F-statistic: 66.09	p-value: <2.2e-16
	Coefficients:	Estimate	Std. error	t value	p-value
	Intercept	-0.008870	0.004896	-1.812	0.0726
	MKTRF	1.275790	0.119738	10.655	<2e-16
	SMB	-0.259626	0.223457	***-1.162***	0.2477
	HML	0.925398	0.183166	***5.052***	1.64e-06

UBS:

CAPM model	***R^2: 0.3906***	***Adj. R^2: 0.3854***	F-statistic: 74.99	p-value: 3.038e-14
	Coefficients:	estimate	Std. error	t value	p-value
	intercept	-0.011735	0.008221	-1.427	0.156
	MKTRF	1.569597	0.181254	8.660	3.04e-14
3 factor model	***R^2: 0.4295***	***Adj. R^2: 0.4146***	F-statistic: 28.86	p-value: 5.525e-14
	Coefficients:	Estimate	Std. error	t value	p-value
	Intercept	-0.010084	0.008056	-1.253	0.21259
	MKTRF	1.457335	0.197123	7.393	2.51e-11
	SMB	-0.311344	0.367843	***-0.846***	0.39908
	HML	0.824620	0.301755	***2.733***	0.00727

We test at alpha=5%, critical t=1.96. If the absolute value of t value are larger than 1.96, then we reject the null hypothesis that coefficient=0.

Conclusion: All three firms the coefficients of SMB not significant , HML significant.

The R^2 and adjusted R^2:

All three firms the R^2 and adjusted R^2 of 3 factor model are larger than those of CAPM model.

Does 3 factor model have greater explanatory power than CAPM?

Generally we can see that the R^2 and adjusted R^2 of 3 factor model are all slightly better than CAPM model. Even though the difference aren't that big, but ***we do think that 3 factor model has greater explanatory power than CAPM.***

- Collinearity problem

Regression	R^2	Adjusted R^2
MKTRF~HML,SMB	0.1879	0.1741
HML~MKTRF,SMB	0.1135	0.09832
SMB~MKTRF,HML	0.1296	0.1148

All metrics are quite small, thus ***consider collinearity not a big problem in three factor model.***

- So is it necessary to use three factor model or CAPM is enough? Use F test to check whether SMB, HML variable have significant explanatory power. Set significance level = 5%.

	F-statistic	p-value
AXP	4.3105	***0.01564***
GE	12.982	***8.171e-06***
UBS	3.9184	***0.02258***

Null hypothesis is that coefficient of SMB and HML both =0. However all three firms the p-value are smaller than 2.5%, all are significant enough to reject the null hypothesis. ***We can say that at least one of these two explanatory variables have significant explanatory power.***

- See if firms behave differently in good or bad conditions :
  Null hypothesis is that coefficients of dummy variables all =0.

Results of running F test:

	F-statistic	p-value
AXP	1.8444	***0.1253***
GE	2.1776	***0.07604***
UBS	1.577	***0.1854***

All three firms are not significant enough to reject the null hypothesis that coefficients of dummy variables = 0. However the results of GE is actually quite significant, just not enough to reject the null hypothesis.

- Heteroskedasticity

  Use White test to examine if the residuals of CAPM model show significant heteroskedasticity.

  R^2 of running regression{ error^2~MKTRF+MKTRF^2 } :
  AXP: 0.1175 GE: 0.001425 UBS: 0.1225

  Test statistic = N*R^2 = 120*R^2 above
  AXP: 14.100 GE: 0.171 UBS: 14.700

  Critical value under alpha=5%, degree of freedom=2 : 5.99

  ⇨ Test statistics of AXP, UBS are larger than critical value, GE is not.

  ⇨ ***We reject the null hypothesis and conclude that the CAPM model of AXP & UBS show significant heteroskedasticity.***

Compare the original OLS results of CAPM with the results of robust regression (white standard error) :

AXP:

CAPM	Coefficients:	Value	Std. error	t value
	Intercept	-0.0009649	0.0079261	-0.122
	MKTRF	1.6369379	0.1752438	9.341
Robust	Coefficients	Value	Std. error	t value
	Intercept	-0.0023	0.0047	-0.4853
	MKTRF	1.3111	0.1047	12.5270

GE:

CAPM	Coefficients:	Value	Std. error	t value
	Intercept	-0.010878	0.005353	-2.032
	MKTRF	1.416312	0.118351	11.967

Robust	Coefficients	Value	Std. error	t value
	Intercept	-0.0101	0.0047	-2.1495
	MKTRF	1.3720	0.1041	13.1814

UBS:

CAPM	Coefficients:	Value	Std. error	t value
	Intercept	-0.011735	0.008221	-1.427
	MKTRF	1.569597	0.181254	8.660
Robust	Coefficients	Value	Std. error	t value
	Intercept	-0.0156	0.0073	-2.1272
	MKTRF	1.5888	0.1621	9.7988

- Whether there exists serial correlation in CAPM model residuals.

Running regression of CAPM model residuals ~ MKTRF & lag residuals:

R^2 : AXP: 0.008287 GE: 0.0006347 UBS: 0.004407

Adjusted R^2 : AXP: -0.008666 GE: -0.01645 UBS: -0.01261

All R^2 are very small, not even larger than 2%. ***We conclude that serial correlation is not a big problem in these three firms' CAPM model.***