

```

> # load the packages that can read SAS files and can run white standard e
rror
> library(haven)
> library(MASS)
>
> # load in data
> data<-read_sas("regdata.sas7bdat")
> file<-read_sas("mktdata.sas7bdat")
>
> AXP<-unlist(data[c(601:720),10])
> GE<-unlist(data[c(2041:2160),10])
> UBS<-unlist(data[c(5641:5760),10])
> MKTRF<- unlist(file["MKTRF"])
> SMB<- unlist(file["SMB"])
> HML<- unlist(file["HML"])
> D_axp<- unlist(data[c(601:720),9])
> D_ge<-unlist(data[c(2041:2160),9])
> D_ubs<-unlist(data[c(5641:5760),9])
> DMKTRF_axp<-D_axp*MKTRF
> DMKTRF_ge<-D_ge*MKTRF
> DMKTRF_ubs<-D_ubs*MKTRF
> DHML_axp<-D_axp*HML
> DHML_ge<-D_ge*HML
> DHML_ubs<-D_ubs*HML
> DSMB_axp<-D_axp*SMB
> DSMB_ge<-D_ge*SMB
> DSMB_ubs<-D_ubs*SMB
>
>
> # CAPM & 3 factor model
> summary(lm(AXP~MKTRF))

```

Call:

```
lm(formula = AXP ~ MKTRF)
```

Residuals:

Min	1Q	Median	3Q	Max
-0.23172	-0.02952	-0.00501	0.02686	0.69760

Coefficients:

```
      Estimate Std. Error t value Pr(>|t|)
(Intercept) -0.0009649  0.0079261  -0.122    0.903
MKTRF        1.6369379  0.1752438   9.341 7.28e-16 ***
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Residual standard error: 0.0855 on 118 degrees of freedom
Multiple R-squared: 0.4251, Adjusted R-squared: 0.4202
F-statistic: 87.25 on 1 and 118 DF, p-value: 7.279e-16

```
> summary(lm(GE~MKTRF))
```

Call:

```
lm(formula = GE ~ MKTRF)
```

Residuals:

```
      Min       1Q   Median       3Q      Max
-0.18814 -0.03157 -0.00129  0.03057  0.14148
```

Coefficients:

```
      Estimate Std. Error t value Pr(>|t|)
(Intercept) -0.010878   0.005353  -2.032   0.0444 *
MKTRF        1.416312   0.118351  11.967 <2e-16 ***
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Residual standard error: 0.05774 on 118 degrees of freedom
Multiple R-squared: 0.5483, Adjusted R-squared: 0.5444
F-statistic: 143.2 on 1 and 118 DF, p-value: < 2.2e-16

```
> summary(lm(UBS~MKTRF))
```

Call:

```
lm(formula = UBS ~ MKTRF)
```

Residuals:

```
      Min       1Q   Median       3Q      Max
-0.267721 -0.049266 -0.004977  0.058620  0.298141
```

Coefficients:

```
      Estimate Std. Error t value Pr(>|t|)
```

```
(Intercept) -0.011735  0.008221 -1.427    0.156
MKTRF        1.569597  0.181254  8.660 3.04e-14 ***
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Residual standard error: 0.08838 on 117 degrees of freedom
 (1 observation deleted due to missingness)
 Multiple R-squared: 0.3906, Adjusted R-squared: 0.3854
 F-statistic: 74.99 on 1 and 117 DF, p-value: 3.038e-14

```
> summary(lm(AXP~MKTRF+HML+SMB))
```

```
Call:
lm(formula = AXP ~ MKTRF + HML + SMB)
```

```
Residuals:
    Min       1Q   Median       3Q      Max
-0.23205 -0.03620 -0.00137  0.02796  0.66435
```

```
Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 0.0007908  0.0077379   0.102   0.9188
MKTRF        1.4492480  0.1892319   7.659 6.18e-12 ***
HML          0.8324850  0.2894716   2.876  0.0048 **
SMB          0.1068824  0.3531479   0.303  0.7627
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Residual standard error: 0.0832 on 116 degrees of freedom
 Multiple R-squared: 0.4649, Adjusted R-squared: 0.451
 F-statistic: 33.59 on 3 and 116 DF, p-value: 1.06e-15

```
> summary(lm(GE~MKTRF+HML+SMB))
```

```
Call:
lm(formula = GE ~ MKTRF + HML + SMB)
```

```
Residuals:
    Min       1Q   Median       3Q      Max
-0.191311 -0.028630 -0.000417  0.029838  0.143054
```

```
Coefficients:
```

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	-0.008870	0.004896	-1.812	0.0726 .
MKTRF	1.275790	0.119738	10.655	< 2e-16 ***
HML	0.925398	0.183166	5.052	1.64e-06 ***
SMB	-0.259626	0.223457	-1.162	0.2477

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.05265 on 116 degrees of freedom
Multiple R-squared: 0.6309, Adjusted R-squared: 0.6213
F-statistic: 66.09 on 3 and 116 DF, p-value: < 2.2e-16

```
> summary(lm(UBS~MKTRF+HML+SMB))
```

Call:

```
lm(formula = UBS ~ MKTRF + HML + SMB)
```

Residuals:

Min	1Q	Median	3Q	Max
-0.24591	-0.05341	-0.01349	0.05447	0.27794

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	-0.010084	0.008045	-1.253	0.21259
MKTRF	1.457335	0.197123	7.393	2.51e-11 ***
HML	0.824620	0.301755	2.733	0.00727 **
SMB	-0.311344	0.367843	-0.846	0.39908

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.08625 on 115 degrees of freedom
(1 observation deleted due to missingness)
Multiple R-squared: 0.4295, Adjusted R-squared: 0.4146
F-statistic: 28.86 on 3 and 115 DF, p-value: 5.525e-14

```
>
>
> # collinearity
> summary(lm(MKTRF~HML+SMB,data=file))
```

Call:

```
lm(formula = MKTRF ~ HML + SMB, data = file)
```

Residuals:

Min	1Q	Median	3Q	Max
-0.154032	-0.021509	0.000784	0.026927	0.087599

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	0.007204	0.003721	1.936	0.055293 .
HML	0.422349	0.135925	3.107	0.002371 **
SMB	0.569361	0.164306	3.465	0.000741 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.04065 on 117 degrees of freedom

Multiple R-squared: 0.1879, Adjusted R-squared: 0.1741

F-statistic: 13.54 on 2 and 117 DF, p-value: 5.139e-06

```
> summary(lm(HML~MKTRF+SMB,data=file))
```

Call:

```
lm(formula = HML ~ MKTRF + SMB, data = file)
```

Residuals:

Min	1Q	Median	3Q	Max
-0.094186	-0.015395	-0.002555	0.010903	0.083496

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	-0.002146	0.002463	-0.871	0.38537
MKTRF	0.180488	0.058087	3.107	0.00237 **
SMB	0.121452	0.112226	1.082	0.28139

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.02657 on 117 degrees of freedom

Multiple R-squared: 0.1135, Adjusted R-squared: 0.09832

F-statistic: 7.488 on 2 and 117 DF, p-value: 0.0008709

```
> summary(lm(SMB~MKTRF+HML,data=file))
```

Call:

```
lm(formula = SMB ~ MKTRF + HML, data = file)
```

Residuals:

Min	1Q	Median	3Q	Max
-0.044015	-0.017698	-0.000184	0.014250	0.056273

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	0.0003231	0.0020255	0.160	0.873531
MKTRF	0.1634796	0.0471769	3.465	0.000741 ***
HML	0.0816025	0.0754038	1.082	0.281386

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.02178 on 117 degrees of freedom

Multiple R-squared: 0.1296, Adjusted R-squared: 0.1148

F-statistic: 8.714 on 2 and 117 DF, p-value: 0.0002967

>

> # chow test

> summary(lm(AXP~MKTRF+SMB+HML+D_axp+DMKTRF_axp+DSMB_axp+DHML_axp))

Call:

lm(formula = AXP ~ MKTRF + SMB + HML + D_axp + DMKTRF_axp + DSMB_axp +
DHML_axp)

Residuals:

Min	1Q	Median	3Q	Max
-0.22098	-0.03612	0.00662	0.03414	0.60513

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	0.002237	0.019339	0.116	0.908110
MKTRF	1.512422	0.387531	3.903	0.000163 ***
SMB	-0.253921	0.633301	-0.401	0.689222
HML	0.240124	0.416775	0.576	0.565672
D_axp	-0.023094	0.024611	-0.938	0.350071
DMKTRF_axp	0.411954	0.544796	0.756	0.451139
DSMB_axp	0.458958	0.761238	0.603	0.547787
DHML_axp	1.099894	0.574682	1.914	0.058183 .

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.08201 on 112 degrees of freedom
Multiple R-squared: 0.4979, Adjusted R-squared: 0.4666
F-statistic: 15.87 on 7 and 112 DF, p-value: 2.436e-14

```
> summary(lm(GE~MKTRF+SMB+HML+D_ge+DMKTRF_ge+DSMB_ge+DHML_ge))
```

Call:

```
lm(formula = GE ~ MKTRF + SMB + HML + D_ge + DMKTRF_ge + DSMB_ge +  
    DHML_ge)
```

Residuals:

Min	1Q	Median	3Q	Max
-0.18016	-0.02693	-0.00018	0.02643	0.14449

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	0.008784	0.012169	0.722	0.471887
MKTRF	1.400027	0.243856	5.741	8.17e-08 ***
SMB	-0.106623	0.398508	-0.268	0.789533
HML	0.940861	0.262258	3.588	0.000496 ***
D_ge	-0.040772	0.015487	-2.633	0.009666 **
DMKTRF_ge	0.413161	0.342816	1.205	0.230667
DSMB_ge	-0.144368	0.479013	-0.301	0.763679
DHML_ge	-0.064645	0.361622	-0.179	0.858446

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.05161 on 112 degrees of freedom
Multiple R-squared: 0.6575, Adjusted R-squared: 0.6361
F-statistic: 30.72 on 7 and 112 DF, p-value: < 2.2e-16

```
> summary(lm(UBS~MKTRF+SMB+HML+D_ubs+DMKTRF_ubs+DSMB_ubs+DHML_ubs))
```

Call:

```
lm(formula = UBS ~ MKTRF + SMB + HML + D_ubs + DMKTRF_ubs + DSMB_ubs +  
    DHML_ubs)
```

Residuals:

Min	1Q	Median	3Q	Max
-0.23016	-0.05587	-0.01159	0.04999	0.26771

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	-0.03572	0.02014	-1.774	0.0788 .
MKTRF	0.96172	0.40352	2.383	0.0189 *
SMB	-0.24088	0.65943	-0.365	0.7156
HML	0.40244	0.43397	0.927	0.3558
D_ubs	0.01401	0.02567	0.546	0.5863
DMKTRF_ubs	0.87873	0.56731	1.549	0.1242
DSMB_ubs	-0.21933	0.79419	-0.276	0.7829
DHML_ubs	0.89127	0.60100	1.483	0.1409

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.0854 on 111 degrees of freedom
 (1 observation deleted due to missingness)
 Multiple R-squared: 0.4602, Adjusted R-squared: 0.4261
 F-statistic: 13.52 on 7 and 111 DF, p-value: 1.562e-12

```
>
> # set the regression model to run F test
> axp<-lm(AXP~MKTRF)
> axp_1<-lm(AXP~MKTRF+SMB+HML)
> axp_2<- lm(AXP~MKTRF+SMB+HML+D_axp+DMKTRF_axp+DSMB_axp+DHML_axp)
> ge<-lm(GE~MKTRF)
> ge_1<-lm(GE~MKTRF+SMB+HML)
> ge_2<- lm(GE~MKTRF+SMB+HML+D_ge+DMKTRF_ge+DSMB_ge+DHML_ge)
> ubs<-lm(UBS~MKTRF)
> ubs_1<-lm(UBS~MKTRF+SMB+HML)
> ubs_2<- lm(UBS~MKTRF+SMB+HML+D_ubs+DMKTRF_ubs+DSMB_ubs+DHML_ubs)
>
> # F test
> anova(axp,axp_1)
Analysis of Variance Table
```

```
Model 1: AXP ~ MKTRF
Model 2: AXP ~ MKTRF + SMB + HML
  Res.Df    RSS Df Sum of Sq    F Pr(>F)
1    118 0.86266
2    116 0.80298 2  0.059677  4.3105 0.01564 *
```

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```
> anova(ge,ge_1)
Analysis of Variance Table
```


Model 1: GE ~ MKTRF

Model 2: GE ~ MKTRF + SMB + HML

	Res.Df	RSS	Df	Sum of Sq	F	Pr(>F)
1	118	0.39346				
2	116	0.32150	2	0.07196	12.982	8.171e-06 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

> anova(ubs,ubs_1)

Analysis of Variance Table

Model 1: UBS ~ MKTRF

Model 2: UBS ~ MKTRF + SMB + HML

	Res.Df	RSS	Df	Sum of Sq	F	Pr(>F)
1	117	0.91382				
2	115	0.85552	2	0.058301	3.9184	0.02258 *

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

> anova(axp_1,axp_2)

Analysis of Variance Table

Model 1: AXP ~ MKTRF + SMB + HML

Model 2: AXP ~ MKTRF + SMB + HML + D_axp + DMKTRF_axp + DSMB_axp + DHML_axp

	Res.Df	RSS	Df	Sum of Sq	F	Pr(>F)
1	116	0.80298				
2	112	0.75336	4	0.049624	1.8444	0.1253

> anova(ge_1,ge_2)

Analysis of Variance Table

Model 1: GE ~ MKTRF + SMB + HML

Model 2: GE ~ MKTRF + SMB + HML + D_ge + DMKTRF_ge + DSMB_ge + DHML_ge

	Res.Df	RSS	Df	Sum of Sq	F	Pr(>F)
1	116	0.3215				
2	112	0.2983	4	0.023199	2.1776	0.07604 .

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

> anova(ubs_1,ubs_2)

Analysis of Variance Table

Model 1: UBS ~ MKTRF + SMB + HML

Model 2: UBS ~ MKTRF + SMB + HML + D_ubs + DMKTRF_ubs + DSMB_ubs + DHML_ubs

	Res.Df	RSS	Df	Sum of Sq	F	Pr(>F)
--	--------	-----	----	-----------	---	--------

```

1  115 0.85552
2  111 0.80951 4 0.046004 1.577 0.1854
>
>
> # set the data for white test
> error_axp<-residuals(lm(AXP~MKTRF))
> error_ge<-residuals(lm((GE~MKTRF)))
>
> UBS<-replace(UBS,83,0.03509)
> # the missing value of the 83th month of UBS will cause problem in the process of running white test and serial correlation, so we find the actual data 3.509% and fill it in, then re-run the CAPM regression and get the residuals
>
> error_ubs<-residuals(lm(UBS~MKTRF))
> error2_axp<-error_axp^2
> error2_ge<-error_ge^2
> error2_ubs<-error_ubs^2
> mktrf2<-MKTRF^2
>
> # white test
> summary(lm(error2_axp~MKTRF+mktrf2))

```

Call:

```
lm(formula = error2_axp ~ MKTRF + mktrf2)
```

Residuals:

Min	1Q	Median	3Q	Max
-0.07061	-0.00878	-0.00017	0.00512	0.42514

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	-0.002177	0.004601	-0.473	0.63700
MKTRF	0.260552	0.088843	2.933	0.00404 **
mktrf2	3.575944	1.104769	3.237	0.00157 **

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.04222 on 117 degrees of freedom

Multiple R-squared: 0.1175, Adjusted R-squared: 0.1024

F-statistic: 7.789 on 2 and 117 DF, p-value: 0.0006673

```
> summary(lm(error2_ge~MKTRF+mktrf2))
```

Call:

```
lm(formula = error2_ge ~ MKTRF + mktrf2)
```

Residuals:

Min	1Q	Median	3Q	Max
-0.004025	-0.003092	-0.002274	-0.000103	0.032168

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	0.0031361	0.0006423	4.883	3.35e-06 ***
MKTRF	0.0028392	0.0124029	0.229	0.819
mktrf2	0.0588337	0.1542313	0.381	0.704

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.005894 on 117 degrees of freedom

Multiple R-squared: 0.001425, Adjusted R-squared: -0.01564

F-statistic: 0.08347 on 2 and 117 DF, p-value: 0.92

```
> summary(lm(error2_ubs~MKTRF+mktrf2))
```

Call:

```
lm(formula = error2_ubs ~ MKTRF + mktrf2)
```

Residuals:

Min	1Q	Median	3Q	Max
-0.022677	-0.005566	-0.003539	0.000851	0.069887

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	0.004421	0.001485	2.977	0.00354 **
MKTRF	0.031807	0.028677	1.109	0.26964
mktrf2	1.439337	0.356595	4.036	9.73e-05 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.01363 on 117 degrees of freedom

Multiple R-squared: 0.1225, Adjusted R-squared: 0.1075

F-statistic: 8.166 on 2 and 117 DF, p-value: 0.0004788

```
>  
>  
> # white standard error  
> summary(rlm(AXP~MKTRF))
```

```
Call: rlm(formula = AXP ~ MKTRF)
```

```
Residuals:
```

Min	1Q	Median	3Q	Max
-0.22472	-0.02742	0.00317	0.02498	0.73213

```
Coefficients:
```

	value	Std. Error	t value
(Intercept)	-0.0023	0.0047	-0.4853
MKTRF	1.3111	0.1047	12.5270

```
Residual standard error: 0.04105 on 118 degrees of freedom
```

```
> summary(rlm(GE~MKTRF))
```

```
Call: rlm(formula = GE ~ MKTRF)
```

```
Residuals:
```

Min	1Q	Median	3Q	Max
-0.187903	-0.031333	-0.002459	0.031345	0.142532

```
Coefficients:
```

	value	Std. Error	t value
(Intercept)	-0.0101	0.0047	-2.1495
MKTRF	1.3720	0.1041	13.1814

```
Residual standard error: 0.04648 on 118 degrees of freedom
```

```
> summary(rlm(UBS~MKTRF))
```

```
Call: rlm(formula = UBS ~ MKTRF)
```

```
Residuals:
```

Min	1Q	Median	3Q	Max
-0.2642129	-0.0449834	-0.0006459	0.0617624	0.3000524

```
Coefficients:
```

	value	Std. Error	t value
(Intercept)	-0.0156	0.0073	-2.1272
MKTRF	1.5888	0.1621	9.7988

```
Residual standard error: 0.07332 on 118 degrees of freedom
```

```

>
>
> # set data for serial correlation
> lag_axp<-vector()
> lag_ge<-vector()
> lag_ubs<-vector()
> lag_axp[1]<-0
> lag_ge[1]<-0
> lag_ubs[1]<-0
> lag_axp[2:120]<-error_axp[1:119]
> lag_ge[2:120]<-error_ge[1:119]
> lag_ubs[2:120]<-error_ubs[1:119]
>
>
> # run serial correlation
> summary(lm(error_axp~MKTRF+lag_axp))

```

Call:

```
lm(formula = error_axp ~ MKTRF + lag_axp)
```

Residuals:

Min	1Q	Median	3Q	Max
-0.23392	-0.03265	-0.00369	0.02640	0.69519

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	-8.162e-05	7.927e-03	-0.010	0.992
MKTRF	1.046e-02	1.756e-01	0.060	0.953
lag_axp	-9.120e-02	9.223e-02	-0.989	0.325

Residual standard error: 0.08551 on 117 degrees of freedom

Multiple R-squared: 0.008287, Adjusted R-squared: -0.008666

F-statistic: 0.4888 on 2 and 117 DF, p-value: 0.6146

```
> summary(lm(error_ge~MKTRF+lag_ge))
```

Call:

```
lm(formula = error_ge ~ MKTRF + lag_ge)
```

Residuals:

Min	1Q	Median	3Q	Max
-0.187327	-0.030692	-0.001918	0.031127	0.141524

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	4.044e-06	5.374e-03	0.001	0.999
MKTRF	-1.703e-03	1.190e-01	-0.014	0.989
lag_ge	2.529e-02	9.278e-02	0.273	0.786

Residual standard error: 0.05797 on 117 degrees of freedom

Multiple R-squared: 0.0006347, Adjusted R-squared: -0.01645

F-statistic: 0.03716 on 2 and 117 DF, p-value: 0.9635

```
> summary(lm(error_ubs~MKTRF+lag_ubs))
```

Call:

```
lm(formula = error_ubs ~ MKTRF + lag_ubs)
```

Residuals:

Min	1Q	Median	3Q	Max
-0.256838	-0.049658	-0.007579	0.062779	0.293046

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	2.921e-05	8.175e-03	0.004	0.997
MKTRF	-8.271e-03	1.811e-01	-0.046	0.964
lag_ubs	-6.667e-02	9.265e-02	-0.720	0.473

Residual standard error: 0.08818 on 117 degrees of freedom

Multiple R-squared: 0.004407, Adjusted R-squared: -0.01261

F-statistic: 0.2589 on 2 and 117 DF, p-value: 0.7723