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1. CAPM model

```
. regress rj rm

      Source |       SS           df       MS      Number of obs   =    11,959
-------------+----------------------------------   F(1, 11957)     =   5988.94
       Model |  11449.5344         1  11449.5344   Prob > F        =    0.0000
    Residual |  22859.1346    11,957  1.91177842   R-squared       =    0.3337
-------------+----------------------------------   Adj R-squared   =    0.3337
       Total |   34308.669    11,958  2.86909759   Root MSE        =    1.3827

------------------------------------------------------------------------------
          rj |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          rm |   .9947206   .0128536    77.39   0.000     .9695254    1.019916
       _cons |   .0084273   .0126552     0.67   0.505    -.0163789    .0332335
------------------------------------------------------------------------------
```

FF model

```
. regress rj rm smb hml

      Source |       SS           df       MS      Number of obs   =    11,959
-------------+----------------------------------   F(3, 11955)     =   2057.22
       Model |  11681.1999         3  3893.73328   Prob > F        =    0.0000
    Residual |  22627.4691    11,955  1.89272013   R-squared       =    0.3405
-------------+----------------------------------   Adj R-squared   =    0.3403
       Total |   34308.669    11,958  2.86909759   Root MSE        =    1.3758

------------------------------------------------------------------------------
          rj |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          rm |   1.005554   .0128271    78.39   0.000     .9804104    1.030697
         smb |   .0371377   .0061189     6.07   0.000     .0251437    .0491318
         hml |   .0562866     .00609     9.24   0.000     .0443492     .068224
       _cons |   .0073088   .0125928     0.58   0.562    -.0173752    .0319928
------------------------------------------------------------------------------
```

From CAPM model, Jensen alpla is "insignificant." Because, t-test falls into rejection region at 95% confidence interval. $\underbrace{P(t>0.67)}_{0.505} > 0.05$

From FF model, it has no Jensen alpha $\underbrace{P(t>0.58)}_{0.562} > 0.05$.

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2. CAPM model

```
. regress rj rm

      Source |       SS           df       MS      Number of obs   =    11,959
-------------+----------------------------------   F(1, 11957)     =   5988.94
       Model |  11449.5344         1  11449.5344   Prob > F        =    0.0000
    Residual |  22859.1346    11,957  1.91177842   R-squared       =    0.3337
-------------+----------------------------------   Adj R-squared   =    0.3337
       Total |   34308.669    11,958  2.86909759   Root MSE        =    1.3827

------------------------------------------------------------------------------
          rj |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          rm |   .9947206   .0128536    77.39   0.000     .9695254    1.019916
       _cons |   .0084273   .0126552     0.67   0.505    -.0163789    .0332335
------------------------------------------------------------------------------

. test rm==1

 ( 1)  rm = 1

       F(  1, 11957) =    0.17
            Prob > F =    0.6813
```

>0.05

FF model

```
. regress rj rm smb hml

      Source |       SS           df       MS      Number of obs   =    11,959
-------------+----------------------------------   F(3, 11955)     =   2057.22
       Model |  11681.1999         3  3893.73328   Prob > F        =    0.0000
    Residual |  22627.4691    11,955  1.89272013   R-squared       =    0.3405
-------------+----------------------------------   Adj R-squared   =    0.3403
       Total |   34308.669    11,958  2.86909759   Root MSE        =    1.3758

------------------------------------------------------------------------------
          rj |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          rm |   1.005554   .0128271    78.39   0.000     .9804104    1.030697
         smb |   .0371377   .0061189     6.07   0.000     .0251437    .0491318
         hml |   .0562866     .00609     9.24   0.000     .0443492     .068224
       _cons |   .0073088   .0125928     0.58   0.562    -.0173752    .0319928
------------------------------------------------------------------------------

. test rm==1

 ( 1)  rm = 1

       F(  1, 11955) =    0.19
            Prob > F =    0.6651
```

>0.05

CAPM	FF
$H_0: \beta_j = 1$	$H_0: \beta_j = 1$
$H_a: \beta_j \neq 1$	$H_a: \beta_j \neq 1$

From the test above, it used to test wheather portfolio j has the same risk as the market. From the result, it can see that both CAPM model and FF model has the same risk as market ($\beta_j = 1$). Because, the p-value of both model are more than 0.05. It means that we can't reject null hypothesis. Then, portfolio j has the same risk as market

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3. FF model

```
. regress rj rm smb hml
```

Source	SS	df	MS			
Model	11681.1999	3	3893.73328	Number of obs	=	11,959
Residual	22627.4691	11,955	1.89272013	F(3, 11955)	=	2057.22
				Prob > F	=	0.0000
				R-squared	=	0.3405
				Adj R-squared	=	0.3403
Total	34308.669	11,958	2.86909759	Root MSE	=	1.3758

rj	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
rm	1.005554	.0128271	78.39	0.000	.9804104	1.030697
smb	.0371377	.0061189	6.07	0.000	.0251437	.0491318
hml	.0562866	.00609	9.24	0.000	.0443492	.068224
_cons	.0073088	.0125928	0.58	0.562	-.0173752	.0319928

From FF model, we have to set hypothesis by

$H_0 : \beta_2 = 0$

$H_a : \beta_2 \neq 0$

From FF model, $\overbrace{P(t > 6.07)}^{0.000} < 0.05$. We reject null hypothesis that $\beta_2 = 0$. So, it means that there exists significant size premium.

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4. FF model

```
. regress rj rm smb hml
```

Source	SS	df	MS		
				Number of obs	= 11,959
				F(3, 11955)	= 2057.22
Model	11681.1999	3	3893.73328	Prob > F	= 0.0000
Residual	22627.4691	11,955	1.89272013	R-squared	= 0.3405
				Adj R-squared	= 0.3403
Total	34308.669	11,958	2.86909759	Root MSE	= 1.3758

rj	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
rm	1.005554	.0128271	78.39	0.000	.9804104	1.030697
smb	.0371377	.0061189	6.07	0.000	.0251437	.0491318
hml	.0562866	.00609	9.24	0.000	.0443492	.068224
_cons	.0073088	.0125928	0.58	0.562	-.0173752	.0319928

From FF model, we have to set hypothesis by

$H_0: \beta_3 = 0$

$H_a: \beta_3 \neq 0$

From FF model, $\overbrace{P(t > 9.24)}^{0.000} < 0.05$. We reject null hypothesis that $\beta_3 = 0$. So, it means that there exists significant growth premium.

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5. . regress rj rm smb hml

Source	SS	df	MS			
Model	11681.1999	3	3893.73328	Number of obs	=	11,959
Residual	22627.4691	11,955	1.89272013	F(3, 11955)	=	2057.22
				Prob > F	=	0.0000
				R-squared	=	0.3405
				Adj R-squared	=	0.3403
Total	34308.669	11,958	2.86909759	Root MSE	=	1.3758

rj	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
rm	1.005554	.0128271	78.39	0.000	.9804104	1.030697
smb	.0371377	.0061189	6.07	0.000	.0251437	.0491318
hml	.0562866	.00609	9.24	0.000	.0443492	.068224
_cons	.0073088	.0125928	0.58	0.562	-.0173752	.0319928

```
. test smb hml

 ( 1)  smb = 0
 ( 2)  hml = 0

       F(  2, 11955) =   61.20
            Prob > F =    0.0000
```

We have to set hypothesis by

$H_0: \beta_{smb} = \beta_{hml} = 0$

$H_a: \beta_{smb} \neq 0$ or $\beta_{hml} \neq 0$

From the test, it can see that Prob>F = 0.0000 < 0.05. It means that the null hypothesis is rejected ($\beta_{smb} \neq 0$ or $\beta_{hml} \neq 0$). So, FF model is more appropriate.

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6. . regress rj d1 rm smb hml

Source	SS	df	MS
Model	11683.8263	4	2920.95657
Residual	22624.8427	11,954	1.89265875
Total	34308.669	11,958	2.86909759

Number of obs	=	11,959
F(4, 11954)	=	1543.31
Prob > F	=	0.0000
R-squared	=	0.3406
Adj R-squared	=	0.3403
Root MSE	=	1.3757

rj	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
d1	.05393	.045781	1.18	0.239	-.0358082	.1436682
rm	1.005405	.0128275	78.38	0.000	.9802607	1.030549
smb	.0369291	.0061214	6.03	0.000	.0249302	.048928
hml	.0562495	.00609	9.24	0.000	.0443121	.0681868
_cons	.0028773	.0131425	0.22	0.827	-.0228842	.0286388

From $r_{jt} = \alpha_j + \gamma_j D_{1t} + \beta_{j1} r_{mt} + \beta_{j2} r_{smbt} + \beta_{j3} r_{hmlt} + \varepsilon_{jt}$, we can set hypothesis as

$H_0: \gamma_j = 1$

$H_a: \gamma_j \neq 1$

From the test, $P(t>1.18)>0.05$, we cannot reject Null hypothesis. So, $\gamma_j \neq 1$, it is insignificant and have no January effect.

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7.

```
. regress rj d1 rm smb hml
```

Source	SS	df	MS		
				Number of obs =	11,959
				F(4, 11954) =	1543.31
Model	11683.8263	4	2920.95657	Prob > F =	0.0000
Residual	22624.8427	11,954	1.89265875	R-squared =	0.3406
				Adj R-squared =	0.3403
Total	34308.669	11,958	2.86909759	Root MSE =	1.3757

rj	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
d1	.05393	.045781	1.18	0.239	-.0358082	.1436682
rm	1.005405	.0128275	78.38	0.000	.9802607	1.030549
smb	.0369291	.0061214	6.03	0.000	.0249302	.048928
hml	.0562495	.00609	9.24	0.000	.0443121	.0681868
_cons	.0028773	.0131425	0.22	0.827	-.0228842	.0286388

```
. test d1 rm smb hml

 ( 1)  d1 = 0
 ( 2)  rm = 0
 ( 3)  smb = 0
 ( 4)  hml = 0

       F(  4, 11954) = 1543.31
            Prob > F =    0.0000
```
< 0.05

(1) sign

All independent variable (d_1, r_m, smb, hml) have positive correlation with dependent variable (r_j)

(2) Overall test

From F-test, it can see that Prob > F = 0.0000 < 0.05. It means that the null hypothesis is rejected. It is significant.

(3) R-square

In this case, R^2 equals to 34.06%. It represent that the model can explain 34.06% of the variation in the response variable around its mean.

(4) Individual test

From t-test, it can see that p-value of r_m, sml and hml less than 0.05. It means that the null hypothesis cannot be rejected. It is insignificant. However, p-value of d_1 is more than 0.05. It means that the null hypothesis is rejected. It is significant.

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8. The result from chow test is represented by these following table.

```
. reg rj rm smb hml

      Source |       SS           df       MS      Number of obs   =    11,959
-------------+----------------------------------   F(3, 11955)     =   2057.22
       Model |  11681.1999         3  3893.73328   Prob > F        =    0.0000
    Residual |  22627.4691    11,955  1.89272013   R-squared       =    0.3405
-------------+----------------------------------   Adj R-squared   =    0.3403
       Total |   34308.669    11,958  2.86909759   Root MSE        =    1.3758

------------------------------------------------------------------------------
          rj |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          rm |   1.005554   .0128271    78.39   0.000     .9804104    1.030697
         smb |   .0371377   .0061189     6.07   0.000     .0251437    .0491318
         hml |   .0562866     .00609     9.24   0.000     .0443492     .068224
       _cons |   .0073088   .0125928     0.58   0.562    -.0173752    .0319928
------------------------------------------------------------------------------

. sca rss1=e(rss)

. sca n1=e(N)

. reg rj rm smb hml if d1==0

      Source |       SS           df       MS      Number of obs   =    10,974
-------------+----------------------------------   F(3, 10970)     =   1887.21
       Model |  10805.6192         3  3601.87308   Prob > F        =    0.0000
    Residual |   20936.975    10,970  1.90856654   R-squared       =    0.3404
-------------+----------------------------------   Adj R-squared   =    0.3402
       Total |  31742.5942    10,973  2.89279087   Root MSE        =    1.3815

------------------------------------------------------------------------------
          rj |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          rm |   1.008159   .0134224    75.11   0.000     .9818484    1.034469
         smb |   .0364768   .0064347     5.67   0.000     .0238636      .04909
         hml |   .0553364   .0063956     8.65   0.000     .0427998    .0678729
       _cons |   .0027652   .0131985     0.21   0.834    -.0231062    .0286367
------------------------------------------------------------------------------

. sca rss2=e(rss)

. sca n2=e(N)

. reg rj rm smb hml if d1==1

      Source |       SS           df       MS      Number of obs   =       985
-------------+----------------------------------   F(3, 981)       =    169.11
       Model |  872.032797         3  290.677599   Prob > F        =    0.0000
    Residual |  1686.17832       981  1.71883621   R-squared       =    0.3409
-------------+----------------------------------   Adj R-squared   =    0.3389
       Total |  2558.21111       984  2.59980804   Root MSE        =     1.311

------------------------------------------------------------------------------
          rj |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          rm |   .9725647   .0435176    22.35   0.000     .8871664    1.057963
         smb |   .0402395   .0198549     2.03   0.043     .0012766    .0792024
         hml |   .0659675   .0199538     3.31   0.001     .0268104    .1051246
       _cons |   .0580564   .0421181     1.38   0.168    -.0245956    .1407084
------------------------------------------------------------------------------

. sca rss3=e(rss)

. sca n3=e(N)

. sca ChowTest=((rss1-rss2-rss3)/4)/((rss2+rss3)/(n2+n3-4*2))

. sca list ChowTest
  ChowTest =  .56997206

.
```

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In this case, I also perform Chow test using dummy variable technique. The result is shown by these table.

generate d1rm = d1*rm

generate d1smb = d1*smb

generate d1hml = d1*hml

slope dummy

intercept dummy

```
. regress rj rm smb hml d1 d1rm d1smb d1hml
```

Source	SS	df	MS
Model	11685.5157	7	1669.35938
Residual	22623.1533	11,951	1.89299249
Total	34308.669	11,958	2.86909759

Number of obs	=	11,959
F(7, 11951)	=	881.86
Prob > F	=	0.0000
R-squared	=	0.3406
Adj R-squared	=	0.3402
Root MSE	=	1.3759

rj	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
rm	1.008159	.0133675	75.42	0.000	.9819563	1.034361
smb	.0364768	.0064084	5.69	0.000	.0239153	.0490383
hml	.0553364	.0063695	8.69	0.000	.0428511	.0678216
d1	.0552912	.0461135	1.20	0.231	-.0350988	.1456811
d1rm	-.035594	.0475853	-0.75	0.454	-.1288689	.0576808
d1smb	.0037628	.0217997	0.17	0.863	-.0389682	.0464937
d1hml	.0106311	.0218876	0.49	0.627	-.0322721	.0535344
_cons	.0027652	.0131445	0.21	0.833	-.0230002	.0285307

> 0.05

From the test, variable d1rm, d1smb and d1hml are insignificant. We cannot reject null hypothesis of these variable.

```
. test d1rm d1smb d1hml d1

 ( 1)  d1rm = 0
 ( 2)  d1smb = 0
 ( 3)  d1hml = 0
 ( 4)  d1 = 0

       F(  4, 11951) =    0.57
            Prob > F =    0.6844
```

>0.05

From the test, it can see that Prob > F = 0.6844 >0.05. It means that the null hypothesis is not rejected. It is insignificant.

So, we can see from chow-test above that January and other month share the same structure of Fama-French model.