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From the given data set, estimate the following models:

Capital Asset Pricing Model (CAPM)

CAPM: $$r_{jt} = \alpha_j + \beta_{j1} r_{mt} + \varepsilon_{jt} \quad (1)$$

Fama & French three-factor Model (FF)

Fama & French: $$r_{jt} = \alpha_j + \beta_{j1} r_{mt} + \beta_{j2} r_{smbt} + \beta_{j3} r_{hmlt} + \varepsilon_{jt} \quad (2)$$

```
. reg 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


. 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
------------------------------------------------------------------------------

. test rm=1

 ( 1)  rm = 1

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

1. Determine whether there exists significant Jensen Alpha.

Jensen alpha is insignificant because p-value in CAPM equals to 0.505 and p-value in FF model equals to 0.562 which are greater than 0.05.

2. Determine whether portfolio j has the same risk as the market.

If beta equals to 1, it means portfolio j has the same risk as the market. Therefore, we have to perform hypothesis testing.

After running the hypothesis testing, in CAPM model, p-value equals to 0.6813 which is higher than 0.05 so we fail to reject null hypothesis. Hence, portfolio j has the same risk as the market.

In FF model, p-value equals to 0.6651 which is greater than 0.05 so we fail to reject the null hypothesis. Hence, portfolio j also has the same risk as the market.

3. Determine whether there exists significant size premium

Using the data from FF model, p-value is rejected (p-value: 0.000<0.05). Therefore, there exists significant size premium.

4. Determine whether there exists significant growth (value) premium

Using the data from FF model, p-value is rejected (p-value: 0.000<0.05). Therefore, there exists significant growth premium.

5. Compare CAPM and FF models and determine which model is the most appropriated model. why?

To find the most appropriated model, we have to test the hypothesis Ho: $\beta 2 = \beta 3 = 0$

```
. test smb hml

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

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

We can see that p-value which is 0.0000 is less than 0.05 so p-value is rejected. Hence, FF model is the most appropriate model.

To study calendar effect (January effects) from the data set, estimate the following models:

$$r_{jt} = \alpha_j + \gamma_j D_{1t} + \beta_{j1} r_{mt} + \beta_{j2} r_{smbt} + \beta_{j3} r_{hmlt} + \varepsilon_{jt} \quad (3)$$

where: $D_{1t} = 1$ on January and $= 0$ otherwise.

6. Determine whether there exist significant January effects.

```
. reg rj rm smb hml d1
```

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]
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
d1	.05393	.045781	1.18	0.239	-.0358082	.1436682
_cons	.0028773	.0131425	0.22	0.827	-.0228842	.0286388

From the table, we can see that January effects(D1) is insignificant because p-value, which is 0.239 greater than 0.05, is rejected.

7. Make interpretation of estimated result of model (3) (including (1) sign, (2) overall test, (3) R-square, and (4) individual test).

From the table above, we can interpret that the return on market portfolio (1.01), SMB, HML, D1, and interception are positive. For the overall test, F-test indicates that p-value for F-test is significant since null hypothesis is rejected (p-value: 0.0000<0.05). It means that the 4 variables are adequate to explain portfolio j. For the R-square, it indicates variation in rj by 34.06%. For the individual test, SMB and HML generate the significant variables because p-value is rejected (p-value: 0.0000<0.05). However, D1 is failed to reject since p-value is 0.239 which higher than 0.05. To conclude, January effects does not affect portfolio j.

$$
\begin{aligned}
r_{jt} &= \alpha_j + \beta_{j1} r_{mt} + \beta_{j2} r_{smbt} + \beta_{j3} r_{hmlt} \\
&\quad + \gamma_j D_{1t} + \beta_{j1} D_{1t} r_{mt} + \beta_{j2} D_{1t} r_{smbt} + \beta_{j3} D_{1t} r_{hmlt} + \varepsilon_{jt} \qquad (4)
\end{aligned}
$$

8. Perform Chow-test (using Intercept and Slope Dummy) whether January and other month share the same structure of the Fama-French model (Model (2) vs Model (4)).

```
. reg rj rm smb hml
```

Source	SS	df	MS
Model	11681.1999	3	3893.73328
Residual	22627.4691	11,955	1.89272013
Total	34308.669	11,958	2.86909759

Number of obs	=	11,959
F(3, 11955)	=	2057.22
Prob > F	=	0.0000
R-squared	=	0.3405
Adj R-squared	=	0.3403
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

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```
. 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+n3-2*4))

. sca list Chowtest
  Chowtest =          .
```

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```
. g rmd1=rm*d1

. g smbd1=smb*d1

. g hmld1=hml*d1

. reg rj rm smb hml d1 rmd1 smbd1 hmld1

      Source |       SS           df       MS      Number of obs   =    11,959
-------------+----------------------------------   F(7, 11951)     =    881.86
       Model |  11685.5157         7  1669.35938   Prob > F        =    0.0000
    Residual |  22623.1533    11,951  1.89299249   R-squared       =    0.3406
-------------+----------------------------------   Adj R-squared   =    0.3402
       Total |   34308.669    11,958  2.86909759   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
        rmd1 |   -.035594   .0475853    -0.75   0.454    -.1288689    .0576808
       smbd1 |   .0037628   .0217997     0.17   0.863    -.0389682    .0464937
       hmld1 |   .0106311   .0218876     0.49   0.627    -.0322721    .0535344
       _cons |   .0027652   .0131445     0.21   0.833    -.0230002    .0285307
------------------------------------------------------------------------------

. test d1 rmd1 smbd1 hmld1

 ( 1)  d1 = 0
 ( 2)  rmd1 = 0
 ( 3)  smbd1 = 0
 ( 4)  hmld1 = 0

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

Chow Test and FF model failed to reject January effect since Ho: d1=rmd1=smbd1=hmld1=0 is failed to reject. Hence, there is no structure change (p-value: 0.6844>0.05)