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Capital Asset Pricing Model (CAPM)

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

```
. 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
```

Fama & French three-factor Model (FF)

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

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. 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
```

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(1) Determine whether there exists significant Jensen Alpha.

As the result shows, according to CAPM, we cannot reject null hypothesis: H_0: $\alpha_j = 0$. Therefore, Jensen Alpha is insignificant where p-value = 0.505 is greater than 0.05.

From regressing FF model, we also found that Jensen Alpha is insignificant since p-value = 0.562 is greater than 0.05. So, we cannot reject H_0: $\alpha_j = 0$.

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

According to CAPM, we cannot reject the null hypothesis: $H_{0:}\ \beta_{j1} = 1$ since F = 0.17 with p-value = 0.6813 is greater than 0.05. At 95% level of significant, we cannot reject null hypothesis, that is portfolio j has the same risk as the market.

We also found the same result with FF model, we cannot reject the null hypothesis: $H_{0:}\ \beta_{j1} = 1$ since F = 0.19 with p-value = 0.6651 is greater than 0.05. Therefore, portfolio j has the same risk as the market.

(3) Determine whether there exists significant size premium.

By regress FF model, we reject null hypothesis: $H_{0:}\ \beta_{j2} = 0$ at 95% level of significant where t = 6.07 and p-value = 0.000 is less than 0.05. So, there exists significant size premium.

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

By regress FF model, we reject null hypothesis: $H_{0:}\ \beta_{j3} = 0$ at 95% level of significant where t = 9.24 and p-value = 0.000 is less than 0.05. So, there exists significant growth premium.

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

```
. test smb hml

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

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

Since the coefficients of both size premium and value premium are significant, including both variables in the model will be able to explain more of observation as R-squared is higher. Therefore, FF model is more appropriate.

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

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

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

```
. 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

(6) Determine whether there exist significant January effects.

We cannot reject the null hypothesis: H_0: $\gamma_j = 0$ since at t=1.18, p-value = 0.239 is greater than 0.05. Therefore, January effect is insignificant.

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

7.1)

α_j = .0028773

γ_j = .05393 ; The January effect has positive effect to excess return on portfolio j

β_{j1} = 1.005405, β_{j2} = .0369291, β_{j3} = .0562495 ; As return on market portfolio, size premium, and value premium, increase the higher excess return on portfolio j

7.2) As Prob > F = 0.0000 is less than 0.05, the null hypothesis can be rejected. Therefore, the model is significant.

7.3) R-squared = 0.3406 can be interpreted as model (3) can explain 34.06% of observed data.

7.4) Coefficients of rm, smb, hml are significant at 95% level of significant since p-value are equal to 0.000 which is less than 0.05. While γ_j and α_j are insignificant since p-value from the regression is equal to 0.239 and 0.827 greater than 0.05. So, we cannot reject the null hypothesis: H_0: $\gamma_j = 0$, H_0: $\alpha_j = 0$

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

(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)).

```
. g drm=d1*rm

. g dsmb=d1*smb

. g dhml=d1*hml
```

```
. reg rj rm drm smb dsmb hml dhml d1

      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

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

. test drm dsmb dhml d1

 ( 1)  drm = 0
 ( 2)  dsmb = 0
 ( 3)  dhml = 0
 ( 4)  d1 = 0

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

As d1 = 0, there is no significant January effect, therefore, other months share the same structure of FF model. That is we can estimate every month by one model.