Assignment 2
Answer Guideline

In the recent finance literatures, it is suggested that asset prices are well described by a so-called factor model. According to Capital Asset Pricing Model (CAPM: Model (1)), excess return of particular stock is linearly explained by excess returns of the market portfolio.

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

Where: r_{jt} = excess return on portfolio j at time t and
j = 1, 2, …., 25 portfolios categorized by five groups of firm size and five groups of value of the stock.
r_{mt} = excess return on market portfolio at time t – representing market risk premium.

However, some other literatures have claimed that macroeconomic factors play important role in determining the return of the portfolio. Then, the model should be Arbitrage Pricing Model (APM: Model (2)) as

APT: $$r_{jt} = \alpha_j + \beta_{j1} r_{mt} + \gamma_{j2} r_{intt} + \gamma_{j3} r_{fxt} + \gamma_{j4} r_{goldt} + \gamma_{j5} r_{oilt} + \varepsilon_{jt} \quad (2)$$

Where: r_{intt} = interest rate at time t – expected to have negative relationship.
r_{fxt} = change in exchange rate at time t – expected to have negative impacts.
r_{goldt} = change in gold price at time t –expected to have negative impacts.
r_{oilt} = change in oil price at time t –expected to have negative impacts.

From the data set ***assign02.dta***:

(1) Regress CAPM (Model (1)) and APM (Model (2)). Make interpretation of the estimated results.

CAPM

```
. reg r_j r_m

      Source |       SS           df       MS      Number of obs   =     1,038
-------------+----------------------------------   F(1, 1036)      =    743.67
       Model |   42965.284         1   42965.284   Prob > F        =    0.0000
    Residual |  59854.3032     1,036  57.7744239   R-squared       =    0.4179
-------------+----------------------------------   Adj R-squared   =    0.4173
       Total |  102819.587     1,037  99.1510002   Root MSE        =    7.6009

------------------------------------------------------------------------------
         r_j |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         r_m |   1.179448   .0432502    27.27   0.000      1.09458    1.264316
       _cons |  -.0339569   .2371375    -0.14   0.886    -.4992816    .4313677
------------------------------------------------------------------------------

. est store CAPM
```

Interpretation
1. Sign and Meaning
2. Overall Test – F-test
3. R-squares
4. Individual Test – t-test

APM

```
. reg r_j r_m r_int r_fx r_gold r_oil

      Source |       SS           df       MS      Number of obs   =     1,038
-------------+----------------------------------   F(5, 1032)      =    256.99
       Model |   57022.064         5  11404.4128   Prob > F        =    0.0000
    Residual |  45797.5232     1,032   44.377445   R-squared       =    0.5546
-------------+----------------------------------   Adj R-squared   =    0.5524
       Total |  102819.587     1,037  99.1510002   Root MSE        =    6.6616

------------------------------------------------------------------------------
         r_j |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         r_m |   1.203069   .0379326    31.72   0.000     1.128635    1.277503
       r_int |  -1.182837    .675827    -1.75   0.080    -2.508989    .1433143
        r_fx |  -.7066941   .2065355    -3.42   0.001    -1.111972   -.3014166
      r_gold |  -.1134037   .1891513    -0.60   0.549    -.4845687    .2577612
       r_oil |  -.0478588   .0711611    -0.67   0.501    -.1874957    .0917781
       _cons |    2.29131   1.306534     1.75   0.080    -.2724558    4.855076
------------------------------------------------------------------------------

. est store APM
```

Interpretation

1. Sign and Meaning
2. Overall Test – F-test
3. R-squares
4. Individual Test – t-test

```
. est table CAPM APM, star(.1 .05 .01) stats(N rss F r2 r2_a)

-----------------------------------------------
    Variable |     CAPM             APM
-------------+---------------------------------
         r_m |  1.1794484***    1.2030692***
       r_int |                 -1.1828375*
        r_fx |                  -.7066941***
      r_gold |                 -.11340372
       r_oil |                  -.0478588
       _cons | -.03395695         2.29131*
-------------+---------------------------------
           N |       1038            1038
         rss |  59854.303       45797.523
           F |  743.67308       256.98669
          r2 |  .41787061       .55458367
        r2_a |  .41730871       .55242564
-----------------------------------------------
           legend: * p<.1; ** p<.05; *** p<.01
```

(2) From estimated results of APM, test whether there exists a significant first order autocorrelation problem in the estimated regression model. In case of autocorrelation problem, what are the consequences of the problem? And how can we solve the problem.

Durbin Watson Test

```
. estat dwatson

Durbin-Watson d-statistic(  6,  1038) =   .243831
```

According to Durbin-Watson statistic = 0.243831 which is less than 1.7 (approximate critical value), thus, there exists positive first-order autocorrelation problem.

Consequences include LUE, incorrect estimated of S.E. of estimated coefficients, unreliable t-test and F-test.

The problem can be solve by using Cochrane-Orcutt iterative procedure, which is also FGLS.

(3) From estimated results of APM, without solving autocorrelation problem, determine whether there exists serious multicollinearity problem. Should any independent variables in model (2) be dropped? Why? Give explanation of your decision.

```
. reg r_j r_m r_int r_fx r_gold r_oil

      Source |       SS           df       MS      Number of obs   =     1,038
-------------+----------------------------------   F(5, 1032)      =    256.99
       Model |   57022.064         5  11404.4128   Prob > F        =    0.0000
    Residual |  45797.5232     1,032   44.377445   R-squared       =    0.5546
-------------+----------------------------------   Adj R-squared   =    0.5524
       Total |  102819.587     1,037  99.1510002   Root MSE        =    6.6616

------------------------------------------------------------------------------
         r_j |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         r_m |    1.203069   .0379326    31.72   0.000     1.128635    1.277503
       r_int |   -1.182837    .675827    -1.75   0.080    -2.508989    .1433143
        r_fx |   -.7066941   .2065355    -3.42   0.001    -1.111972   -.3014166
      r_gold |   -.1134037   .1891513    -0.60   0.549    -.4845687    .2577612
       r_oil |   -.0478588   .0711611    -0.67   0.501    -.1874957    .0917781
       _cons |    2.29131   1.306534     1.75   0.080    -.2724558    4.855076
------------------------------------------------------------------------------

. corr r_j r_m r_int r_fx r_gold r_oil
(obs=1,038)

             |      r_j      r_m    r_int     r_fx   r_gold    r_oil
-------------+------------------------------------------------------
         r_j |   1.0000
         r_m |   0.6464   1.0000
       r_int |  -0.0335   0.0167   1.0000
        r_fx |  -0.3452   0.0338   0.0181   1.0000
      r_gold |  -0.3396   0.0325   0.0214   0.9738   1.0000
       r_oil |  -0.0291  -0.0030   0.0804   0.0262   0.0355   1.0000


. estat vif

    Variable |       VIF       1/VIF
-------------+----------------------
      r_gold |     19.41    0.051525
        r_fx |     19.40    0.051555
       r_oil |      1.01    0.991088
       r_int |      1.01    0.992842
         r_m |      1.00    0.998565
-------------+----------------------
    Mean VIF |      8.36

. test r_int r_oil

 ( 1)  r_int = 0
 ( 2)  r_oil = 0

       F(  2,  1032) =    1.86
            Prob > F =    0.1557
```

1. Without solving first-order autocorrelation, insignificant t-test of estimated coefficients of `r_int`, `r_gold`, and `r_oil`; and relatively high correlation between

r_int & r_oil and r_gold & r_fx can be illustrated as signal of multicollinearity problem.

2. With relatively high VIF of 19.41, only insignificant t-test of estimated coefficient of r_gold can be claimed as causing by multicollinearity problem from relatively high relationship between r_gold & r_fx. While low VIF values of r_int and r_oil (1.01) indicate that insignificant t-test of estimated coefficients of r_int and r_oil cannot be claimed as causing by multicollinearity problem
3. Consequently, according to Restricted-Unrestricted F-test of $H_0: \gamma_{j2} = \gamma_{j5} = 0$, with high p-value of 0.1557 > 0.05, the test indicates that both variables should be dropped.

(4) From estimated results of APM, after solving autocorrelation problem, determine whether there exists serious multicollinearity problem. Should any independent variables in model (2) be dropped? Why? Give explanation of your decision.

```
. prais r_j r_m r_int r_fx r_gold r_oil, rho(reg) corc

Iteration 0:  rho = 0.0000
Iteration 1:  rho = 0.8797
Iteration 2:  rho = 0.8831
Iteration 3:  rho = 0.8831
Iteration 4:  rho = 0.8831

Cochrane-Orcutt AR(1) regression -- iterated estimates

      Source |       SS           df       MS      Number of obs   =     1,037
-------------+----------------------------------   F(5, 1031)      =   1869.71
       Model |  93154.7774         5  18630.9555   Prob > F        =    0.0000
    Residual |  10273.5304     1,031  9.96462699   R-squared       =    0.9007
-------------+----------------------------------   Adj R-squared   =    0.9002
       Total |  103428.308     1,036   99.834274   Root MSE        =    3.1567

------------------------------------------------------------------------------
         r_j |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         r_m |    1.20453   .0144841    83.16   0.000     1.176108    1.232952
       r_int |  -.6212559   .2443208    -2.54   0.011    -1.100679   -.1418331
        r_fx |  -.6813838    .070892    -9.61   0.000    -.8204929   -.5422747
      r_gold |  -.1924827   .0650284    -2.96   0.003    -.3200858   -.0648795
       r_oil |   .0009688   .0249378     0.04   0.969    -.0479659    .0499035
       _cons |   1.332575   .9595306     1.39   0.165    -.5502806    3.215431
-------------+----------------------------------------------------------------
         rho |   .8830559
------------------------------------------------------------------------------
Durbin-Watson statistic (original)    0.243831
Durbin-Watson statistic (transformed) 1.936877

. test r_int r_oil

 ( 1)  r_int = 0
 ( 2)  r_oil = 0

       F(  2,  1031) =    3.26
            Prob > F =    0.0389

. test r_oil

 ( 1)  r_oil = 0

       F(  1,  1031) =    0.00
            Prob > F =    0.9690
```

1. After solving first-order autocorrelation, only insignificant t-test of estimated coefficients of `r_oil`; and relatively high correlation between `r_int` & `r_oil` can be used as signal of multicollinearity problem.
2. However, with relatively low VIF values of `r_oil` (1.01) indicate that insignificant t-test of estimated coefficient of `r_oil` cannot be claimed as causing by multicollinearity problem
3. Consequently, according to Restricted-Unrestricted F-test of $H_0: \gamma_{j2} = \gamma_{j5} = 0$, with low p-value of 0.0389 < 0.05, while according to the F-test of $H_0: \gamma_{j5} = 0$, with high p-value of 0.9690 > 0.05, these test results indicate that `r_int` should not be dropped but only `r_oil` should be dropped.