

程序代写代做 CS编程辅导

CAPMGEGO



June 24, 2021

- 1 Calculate the log returns of T-Bill, gold, GE stock and market

```
[92]: import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
```

```
[93]: data = pd.read_csv("C:\\Users\\rluck\\OneDrive\\capm.csv", header=[4])
data
```

```
[93]:
```

	DATE	Gold	S&P500	Rf	GE
0	12/08/1975	166.05	87.12	6.40	0.9218
1	13/08/1975	163.50	85.97	6.45	0.9036
2	14/08/1975	163.50	85.60	6.45	0.9036
3	15/08/1975	163.50	86.36	6.42	0.9244
4	18/08/1975	163.50	86.20	6.42	0.9348
...
10432	6/08/2015	1090.15	2083.56	0.04	26.0300
10433	7/08/2015	1096.85	2077.57	0.06	25.7900
10434	10/08/2015	1103.35	2104.18	0.12	26.2400
10435	11/08/2015	1109.65	2081.07	0.10	25.7100
10436	12/08/2015	1123.85	2086.05	0.10	25.8600

[10437 rows x 5 columns]

#Computing log returns: $R_gold = 100 \cdot \ln(P_g/P_g-1)$

$Rf = 100/360 \cdot \ln(1+rf)$

```
[94]: data['R_gold'] = 100*np.log(data['Gold']/data['Gold'].shift(1))
data['R_f'] = 100/360*np.log(1+data['Rf']/100)
data['R_GE'] = 100*np.log(data['GE']/data['GE'].shift(1))
data['R_m'] = 100*np.log(data['S&P500']/data['S&P500'].shift(1))
print(data.head())
```

	DATE	Gold	S&P500	Rf	GE	R_gold	R_f	R_GE	\
0	12/08/1975	166.05	87.12	6.40	0.9218	NaN	0.017232	NaN	
1	13/08/1975	163.50	85.97	6.45	0.9036	-1.547596	0.017363	-1.994150	
2	14/08/1975	163.50	85.60	6.45	0.9036	0.000000	0.017363	0.000000	

```

3 15/08/1975 163.50 86.36 6.42 0.9244 0.000000 0.017284 2.275809
4 18/08/1975 163.50 86.36 6.42 0.9348 0.000000 0.017284 1.118772

```

```

R_m
0 NaN
1 -1.328808
2 -0.431312
3 0.883932
4 -0.185443

```



2 Calculating R_{gold} and R_{GE}

```

[95]: data['R_p'] = data['R_m'] - data['R_f']
      data['R_ge'] = data['R_GE'] - data['R_f']
      data['R_go'] = data['R_gold'] - data['R_f']

```

```

[95]:
      DATE      Gold  S&P500   Rf      GE  R_gold  R_f \
0  12/08/1975  163.50  86.36  6.40  0.9244  NaN  0.017232
1  13/08/1975  163.50  85.97  6.45  0.9036 -1.547596  0.017363
2  14/08/1975  163.50  85.60  6.45  0.9036  0.000000  0.017363
3  15/08/1975  163.50  86.36  6.42  0.9244  0.000000  0.017284
4  18/08/1975  163.50  86.36  6.42  0.9348  0.000000  0.017284
...
10432  6/08/2015 1090.15 2083.56  0.04 26.0300  0.415484  0.000111
10433  7/08/2015 1096.85 2077.47  0.06 25.7400  0.612713  0.000167
10434  10/08/2015 1102.35 2104.18  0.12 26.2400  0.590857  0.000333
10435  11/08/2015 1109.67 2084.07  0.10 25.7100  0.571167  0.000278
10436  12/08/2015 1123.85 2086.05  0.10 25.8600  1.269762  0.000278

      R_GE      R_m      R_p      R_ge  R_go
0      NaN      NaN      NaN      NaN  NaN
1 -1.994150 -1.328808 -1.346171 -2.011512 -1.564958
2  0.000000 -0.431312 -0.448674 -0.017363 -0.017363
3  2.275809  0.883932  0.866648  2.258525 -0.017284
4  1.118772 -0.185443 -0.202727  1.101488 -0.017284
...
10432 -0.268560 -0.778318 -0.778429 -0.268671  0.415373
10433 -0.926290 -0.287903 -0.288069 -0.926457  0.612547
10434  1.729814  1.272690  1.272357  1.729481  0.590524
10435 -2.040494 -0.960313 -0.960591 -2.040772  0.570889
10436  0.581735  0.094961  0.094684  0.581458  1.269484

```

[10437 rows x 12 columns]

3 Data : Remove N/A

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```
[96]: data = data.dropna(subset=["R_p"])
data.to_csv("C:\\Users\\rluck\\OneDrive\\capm1.csv")
data.head()
```

```
[96]:
```

	DATE	GE	GE	R_gold	R_f	R_GE	\
1	13/08/1975	16.1	0.9036	-1.547596	0.017363	-1.994150	
2	14/08/1975	16.1	0.9036	0.000000	0.017363	0.000000	
3	15/08/1975	16.1	0.9244	0.000000	0.017284	2.275809	
4	18/08/1975	16.1	0.9348	0.000000	0.017284	1.118772	
5	19/08/1975	16.1	0.9218	0.000000	0.017415	-1.400432	

	R_m	R_p	R_ge	R_go
1	-1.328808	-1.346171	-2.011512	-1.564958
2	-0.431312	-0.448674	-0.017363	-0.017363
3	0.883932	0.866648	2.258525	-0.017284
4	-0.185443	-0.202727	1.101488	-0.017284
5	-1.460733	-1.478148	-1.417847	-0.017415

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```
[97]: !pip install sklearn
!pip install statsmodels
```

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Requirement already satisfied: sklearn in c:\users\rluck\anaconda3\lib\site-packages (0.0)

Requirement already satisfied: scikit-learn in c:\users\rluck\anaconda3\lib\site-packages (from sklearn) (0.24.1)

Requirement already satisfied: scipy>=0.19.1 in c:\users\rluck\anaconda3\lib\site-packages (from scikit-learn->sklearn) (1.6.2)

Requirement already satisfied: joblib>=0.11 in c:\users\rluck\anaconda3\lib\site-packages (from scikit-learn->sklearn) (1.0.1)

Requirement already satisfied: numpy>=1.13.3 in c:\users\rluck\anaconda3\lib\site-packages (from scikit-learn->sklearn) (1.20.1)

Requirement already satisfied: threadpoolctl>=2.0.0 in c:\users\rluck\anaconda3\lib\site-packages (from scikit-learn->sklearn) (2.1.0)

Requirement already satisfied: statsmodels in c:\users\rluck\anaconda3\lib\site-packages (0.12.2)

Requirement already satisfied: numpy>=1.15 in c:\users\rluck\anaconda3\lib\site-packages (from statsmodels) (1.20.1)

Requirement already satisfied: scipy>=1.1 in c:\users\rluck\anaconda3\lib\site-packages (from statsmodels) (1.6.2)

Requirement already satisfied: pandas>=0.21 in c:\users\rluck\anaconda3\lib\site-packages (from statsmodels) (1.2.4)

Requirement already satisfied: patsy>=0.5 in c:\users\rluck\anaconda3\lib\site-packages (from statsmodels) (0.5.1)

Requirement already satisfied: python-dateutil>=2.7.3 in c:\users\rluck\anaconda3\lib\site-packages (from pandas>=0.21->statsmodels) (2.8.1)

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Requirement already satisfied: pytz>=2017.3 in
 c:\users\rluck\anaconda3\lib\site-packages (from pandas==0.21.1->statsmodels)
 (2021.1)
 Requirement already satisfied: six in c:\users\rluck\anaconda3\lib\site-packages
 (from patsy>=0.5->statsmodels) (1.15.0)

```
[98]: %matplotlib inline
import statsmodels
import statsmodels
from sklearn import
import matplotlib
```



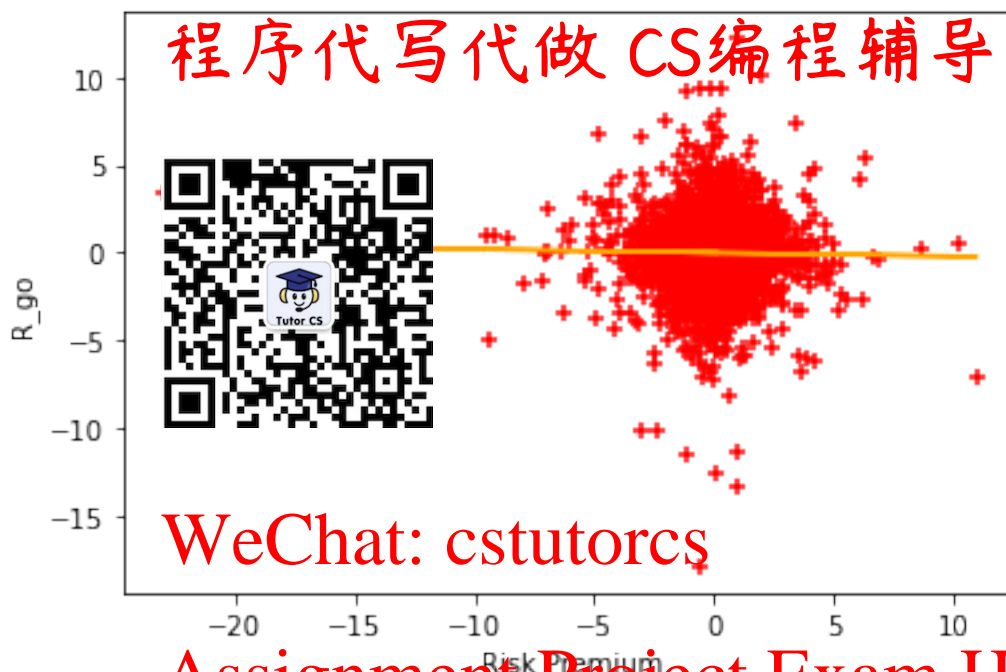
4 I. Plotting Gold excess returns with market excess returns

```
[99]: #Regressing excess returns on gold (R_g) over risk-free rate against the
      ↳ excess market return (Rp=Rm-rf)
reg = linear_model.LinearRegression()
X =data[['R_p']].dropna()
y1 =data[['R_go']].dropna()
reg.fit(X,y1)
predictions =reg.predict(X)
```

```
[100]: plt.xlabel('Risk Premium')
plt.ylabel('R_go')
plt.scatter(data.R_p,data.R_gold,color='red',marker='+')
plt.plot(data.R_p,reg.predict(data[['R_p']]),color='orange')
```

```
[100]: [<matplotlib.lines.Line2D at 0x18397b4e220>]
```

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[101]: `#model with intercept`

```
X= sm.add_constant(X)
model = sm.OLS(y1,X).fit()
predictions = model.predict(X)
j= (model.summary())
print(j)
```

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OLS Regression Results						
Dep. Variable:	R_go	R-squared:	0.000			
Model:	OLS	Adj. R-squared:	0.000			
Method:	Least Squares	F-statistic:	3.181			
Date:	Thu, 24 Jun 2021	Prob (F-statistic):	0.0745			
Time:	13:42:13	Log-Likelihood:	-16959.			
No. Observations:	10436	AIC:	3.392e+04			
Df Residuals:	10434	BIC:	3.394e+04			
Df Model:	1					
Covariance Type:	nonrobust					
	coef	std err	t	P> t	[0.025	0.975]
const	0.0057	0.012	0.473	0.637	-0.018	0.029
R_p	-0.0201	0.011	-1.784	0.075	-0.042	0.002
Omnibus:	2812.110	Durbin-Watson:	2.071			

Prob(Omnibus):	0.000	Jarque-Bera (JB):	111926.422
Skew:	-0.573	Prob(JB):	0.00
Kurtosis:	19.003	Cond. No.	1.07

=====

Notes:

[1] Standard Error covariance matrix of the errors is correctly specified.

DW-stats of 2.071 is that there is no serial correlation.

Yet, the p-value of the indicates that it is slightly significant at 7.5% significance level and the R-squared indicating low explanatory power of the model.



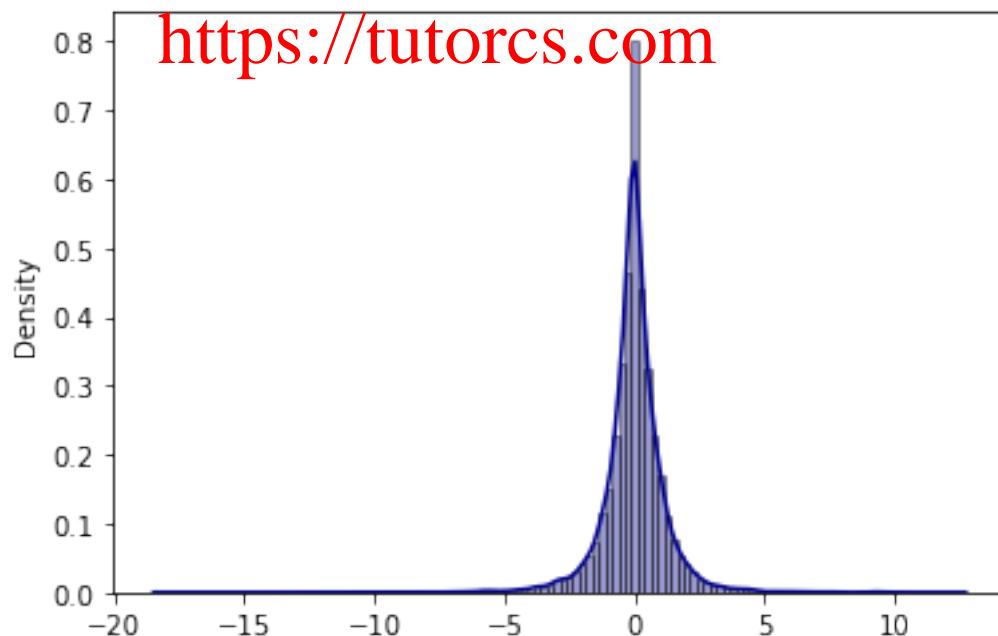
5 Residuals plot for gold

```
[102]: residuals_go = model.resid
import seaborn as sns
sns.distplot(residuals_go, hist=True, kde=True, bins=int(120), color='darkblue', hist_kws={'edgecolor': 'black'})
```

C:\Users\rluck\anaconda3\lib\site-packages\seaborn\distributions.py:2557:
FutureWarning: `distplot` is a deprecated function and will be removed in a future version. Please adapt your code to use either `displot` (a figure-level function with similar flexibility) or `histplot` (an axes-level function for histograms).

warnings.warn(msg, FutureWarning)

```
[102]: <AxesSubplot:ylabel='Density'>
```



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```
[103]: from scipy import stats
JB_go= stats.jarque_bera(residuals go)
JB_go
```

```
[103]: Jarque_beraResult 42195044507, pvalue=0.0)
```

The plot and JB test rejects the null hypothesis of normality. It is clearly a non-normal distribution.



6 Cusum Test for Gold

```
[104]: # endog = data.R_go
Rp = data.R_p
endog = data.R_go
exog = sm.add_constant(Rp)
mod = sm.RecursiveLS(endog,exog)
res_1 = mod.fit()
fig = res_1.plot_cusum(figsize=(10,6));
```

C:\Users\rluck\anaconda3\lib\site-packages\statsmodels\base\tsa_model.py:578: ValueWarning: An unsupported index was provided and will be ignored when e.g. forecasting.
warnings.warn('An unsupported index was provided and will be')



Cusum test of stability for gold shows high periods of instability during the early part of the graph (namely before 1980s) then, the beta stabilises.

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7 White Test of Heteroskedasticity for Gold

```
[105]: from statsmodels. import het_white
       from statsmodels.
       from patsy import

[106]: expr = 'y1 ~ X'
       y1, X = dmatrices
       olsr_results = sm.ols(expr, data).fit()
       keys = ['Lagrange Multiplier statistic:', 'LM test\'s p-value:', 'F-statistic:
       ↪', 'F-test\'s p-value:']
       results = het_white(olsr_results.resid, X
       lzip(keys, results)
```



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```
[106]: [('Lagrange Multiplier statistic:', 36.866651106570274),
       ("LM test's p-value:", 9.874344003655945e-09),
       ('F-statistic:', 18.49335699862814),
       ("F-test's p-value:", 9.608158442586967e-09)]
```

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LM test statistic is 36.87 and the corresponding p-value is 0

F-stats = 18.49 and the corresponding p-value is 0

Since the p-value of the both LM and F-stats is less than 0.05, we reject the null hypothesis that there is no heteroskedasticity in the residuals. It infers that the heteroskedasticity exists and the standard errors need to be corrected.

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8 Breusch-Godfrey LM test for Gold

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```
[107]: import statsmodels.stats.diagnostic as dg
       print (dg.acorr_breusch_godfrey(model, nlags= 2))

(14.058774886495657, 0.0008854740175917412, 7.036171882380294,
0.0008836668869260258)
```

T-statistic of Chi-squared is 14.0588 and the corresponding p-value is 0.0009

F-statistic is 7.0362 and the corresponding p-value is 0.0009

Since p-value is less than 0.05, we reject the null hypothesis, thus inferring there is some autocorrelation at order less than or equal to 2.0

9 II. Plotting GE excess returns with market excess returns

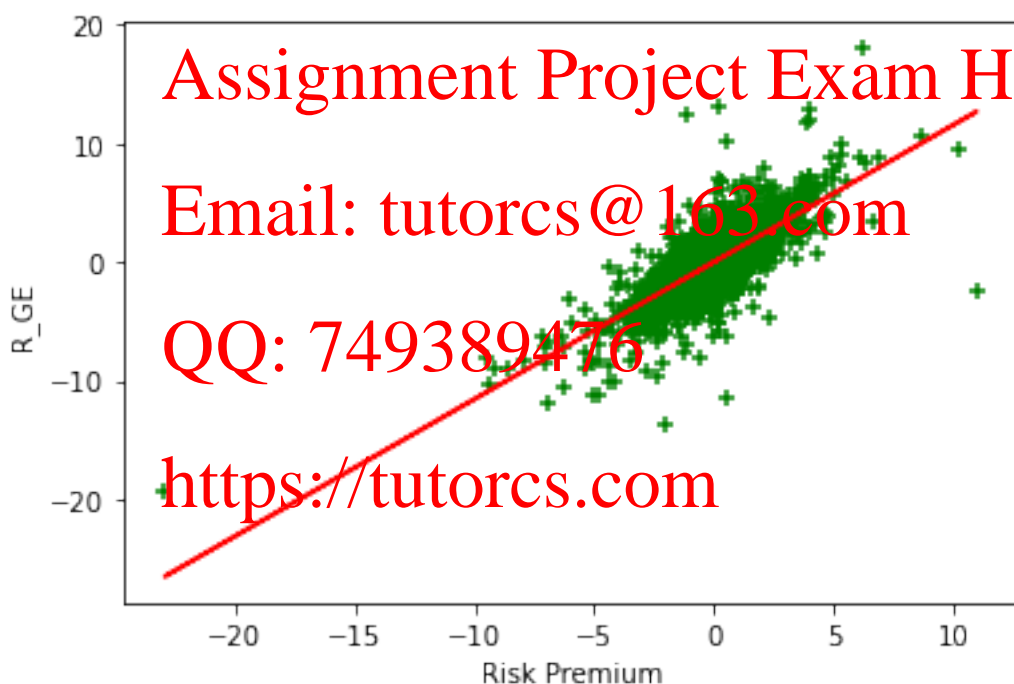
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```
[108]: %matplotlib inline
reg = linear_model.LinearRegression()
X = data[['R_p']]
y = data['R_ge']
reg.fit(X,y)
```

```
[108]: LinearRegression()
```

```
[109]: plt.xlabel('Risk Premium')
plt.ylabel('R_GE')
plt.scatter(data.R_p,data.R_GE,color='green',marker='+')
plt.plot(data.R_p,reg.predict(data[['R_p']]), color='red')
```

```
[109]: [<matplotlib.lines.Line2D at 0x13397269520>]
```



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10 Regressing GE excess return with market excess return

```
[110]: #model with intercept
X = sm.add_constant(X)
model_1 = sm.OLS(y,X).fit()
predictions = model_1.predict(X)
j= (model_1.summary())
```

```
print(j)
```

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OLS Regression Results

```
=====
Dep. Variable:      ge      R-squared:      0.564
Model:              LS      Adj. R-squared:    0.564
Method:             OLS      F-statistic:    1.351e+04
Date:               21      Prob (F-statistic): 0.00
Time:               14      Log-Likelihood:  -15682.
No. Observations:   36      AIC:          3.137e+04
Df Residuals:       34      BIC:          3.138e+04
Df Model:           1
Covariance Type:    nonrobust
=====
```

```
=====
               coef      std err          t      P>|t|      [0.025      0.975]
-----
const         -0.0012     0.011      -0.114     0.909     -0.022     0.020
R_p            1.1569     0.010     116.224     0.000      1.137      1.176
=====
Omnibus:      2325.125      Durbin-Watson:      1.995
Prob(Omnibus):      0.000      Jarque-Bera (JB):      109234.319
Skew:          0.109      Prob(JB):      0.00
Kurtosis:      18.845      Cond. No.      1.07
=====
```

Notes:

[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.

DW-stats of 1.995 is close to 2.0, implying that there is no serial correlation.

Since p-value of the beta coefficient is less than 0.05, we reject the null hypothesis that beta is zero.

The CAPM equation for GE can be written as follows:

$$R_{ge} = 1.1569 * R_p + R_f$$

where R_{ge} is the return from GE stock, $R_p = R_m - R_f$ is the market risk premium and R_f is the risk free rate of return

If we want to replicate the returns from GE, we can rearrange the above equation:

$$R_{ge} = 1.1569 * R_m + (1 - 1.1569) * R_f$$

⇒ We can buy 1.1569 of market portfolio (i.e: S&P500 index fund) and then short 0.1569 T-Bill.

11 Residual Plots for GE

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```
[111]: residuals = model_1.resid
import seaborn as sns
sns.distplot(residuals, hist=True, kde=True, bins=int(120), color=
↳ 'darkblue', hist_kws={'edgecolor': 'black'})
```

C:\Users\rluck\anaconda3\lib\site-packages\seaborn\distributions.py:2557:
FutureWarning: `displot` is a deprecated function and will be removed in a
future version. Please use either `displot` (a figure-level
function with similar semantics to the current `distplot`) or `histplot` (an axes-level function for
histograms).
warnings.warn(msg, FutureWarning)

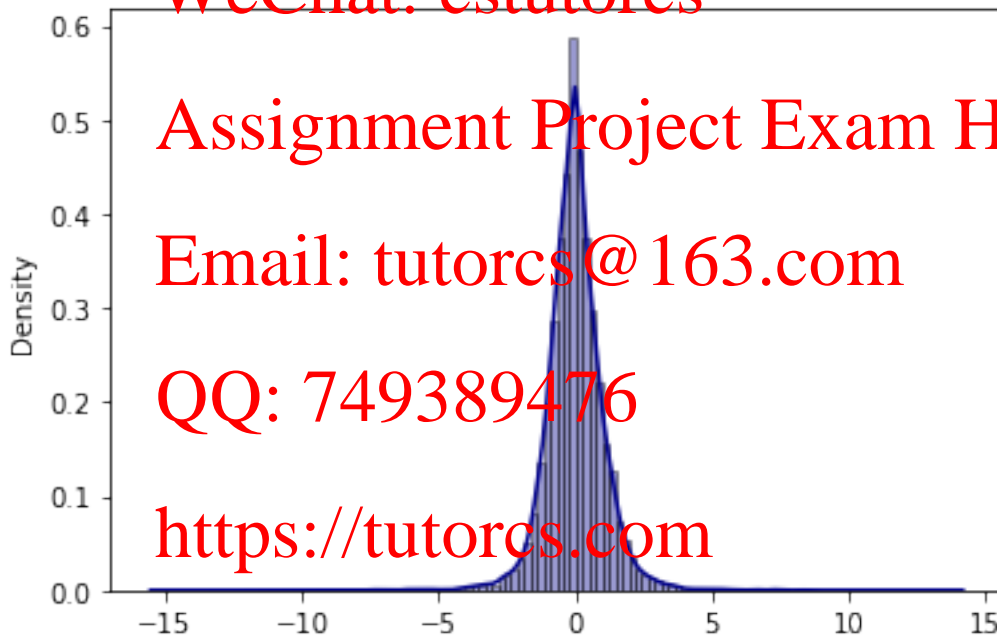
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```
[112]: from scipy import stats
JB_GE = stats.jarque_bera(residuals)
JB_GE
```

```
[112]: Jarque_beraResult(statistic=109234.31887176927, pvalue=0.0)
```

The plot and JB test (p-value < 0.05) rejects the null hypothesis of normality. It is clearly a non-normal distribution.

```
[113]: endog = data.R_ge
Rp = data.R_p
```

```

exog = sm.add_constant(Rp)
mod = sm.RecursiveStereog, exog)
res_1 = mod.fit()
fig = res_1.plot_cusum(figsize=(10,6));

```

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C:\Users\rluck\ana
 packages\statsmode
 index was provided
 warnings.warn('A



del.py:578: ValueWarning: An unsupported
 red when e.g. forecasting.
 ex was provided and will be'



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Cusum test of stability for GE shows stability of beta as it is within the 5% significance level band.

12 White Test of Heteroskedasticity for GE

```

[114]: expr = 'y ~ X'
y, X = dmatrices(expr, data, return_type='dataframe')
olsr_results = smf.ols(expr, data).fit()
keys = ['Lagrange Multiplier statistic:', 'LM test\'s p-value:', 'F-statistic:
↪', 'F-test\'s p-value:']
results = het_white(olsr_results.resid, X)
lzip(keys, results)

```

```

[114]: [('Lagrange Multiplier statistic:', 600.7119211665138),
('LM test's p-value:', 3.606315445696676e-131),
('F-statistic:', 318.60924780728743),

```

("F-test's p-value:", 4.9073934718673876e-135)]

LM test statistic is 600.72 and the corresponding p-value is 0

F-stats = 318.61 and the corresponding p-value is 0

Since the p-value of tests is less than 0.05, we reject the null hypothesis that there is no heteroskedasticity. It infers that the heteroskedasticity exists and the standard errors need

```
[115]: print (dg.acorr_breusch_godfrey(eg1_1, nlags= 2))
```

(5.174836714176367, 0.0013, 2.587709781212114, 0.07524031416320724)

T-statistic of Chi-squared = 5.1748 and the corresponding p-value = 0.075.

F-statistics = 2.5877 and the corresponding p-value = 0.075

Since p-value exceeds 0.05, we fail to reject the null hypothesis, thus inferring there is no autocorrelation at order less than or equal to 2.0

```
[ ]:
```

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13 Extra: Correlation matrix between returns of gold, GE and market

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```
[116]: import seaborn as sns
import pandas as pd
# Import Dataset
data = pd.read_csv('C:\\Users\\rluck\\OneDrive\\capm1.csv',
                  usecols=['R_gold', 'R_m', 'R_GE'])

# Plot
plt.figure(figsize=(12,10), dpi= 80)
sns.heatmap(data.corr(), xticklabels=data.corr().columns, yticklabels=data.
            corr().columns, cmap='RdYlGn', center=0, annot=True)

# Decorations
plt.title('Correlogram of returns', fontsize=22)
plt.xticks(fontsize=12)
plt.yticks(fontsize=12)
plt.show()
```

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