黃金 V.S. 比特幣

時間序列期末報告

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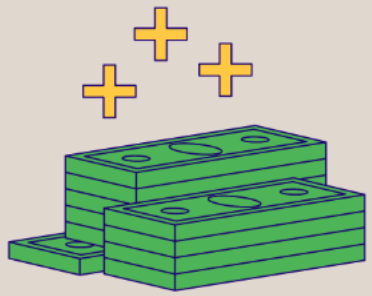
1. 動機目的

動機

2020疫情大爆發，新事件，新影響，一個高風險產品跟一個避險產品在這件事下會產生一樣的趨勢嗎，還是將大相逕庭；利用這一資訊預測出的報酬率是有用的嗎，或是非常糟糕？



目的

預測短期黃金和比特幣未來報酬率和波動，以決定適合的投資組合

2. 資料介紹

XAU/USD歷史數據

時間範圍:

每天 | 下載數據 | 2023-05-03 - 2023-06-04

日期	收市	開市	高	低	成交量	升跌 (%)
2023-6-2	1,947.63	1,978.14	1,983.52	1,947.67		-1.53%
2023-6-1	1,977.88	1,962.80	1,983.27	1,953.43		+0.79%
2023-5-31	1,962.30	1,959.30	1,975.34	1,953.67		+0.16%
2023-5-30	1,959.14	1,944.19	1,963.63	1,932.08		+0.84%
2023-5-29	1,942.84	1,944.09	1,949.75	1,940.30		-0.18%
2023-5-26	1,946.33	1,940.69	1,957.40	1,936.84		+0.31%
2023-5-25	1,940.34	1,958.13	1,964.95	1,938.86		-0.85%
2023-5-24	1,957.01	1,975.19	1,985.30	1,956.51		-0.90%
2023-5-23	1,974.73	1,971.99	1,977.80	1,954.29		+0.27%
2023-5-22	1,969.43	1,977.80	1,982.66	1,968.40		-0.36%
2023-5-19	1,976.56	1,957.40	1,984.09	1,954.05		+0.94%
2023-5-18	1,958.05	1,981.52	1,986.12	1,951.97		-1.19%
2023-5-17	1,981.72	1,988.94	1,993.13	1,974.80		-0.35%
2023-5-16	1,988.60	2,015.90	2,018.94	1,985.47		-1.48%
2023-5-15	2,018.41	2,011.72	2,022.20	2,007.28		+0.36%
2023-5-12	2,011.15	2,015.19	2,022.56	2,001.05		-0.22%
2023-5-11	2,015.55	2,030.56	2,041.44	2,011.19		-0.69%
2023-5-10	2,029.51	2,034.19	2,048.22	2,021.57		-0.23%
2023-5-9	2,034.17	2,022.24	2,037.70	2,019.50		+0.63%

資料來源：

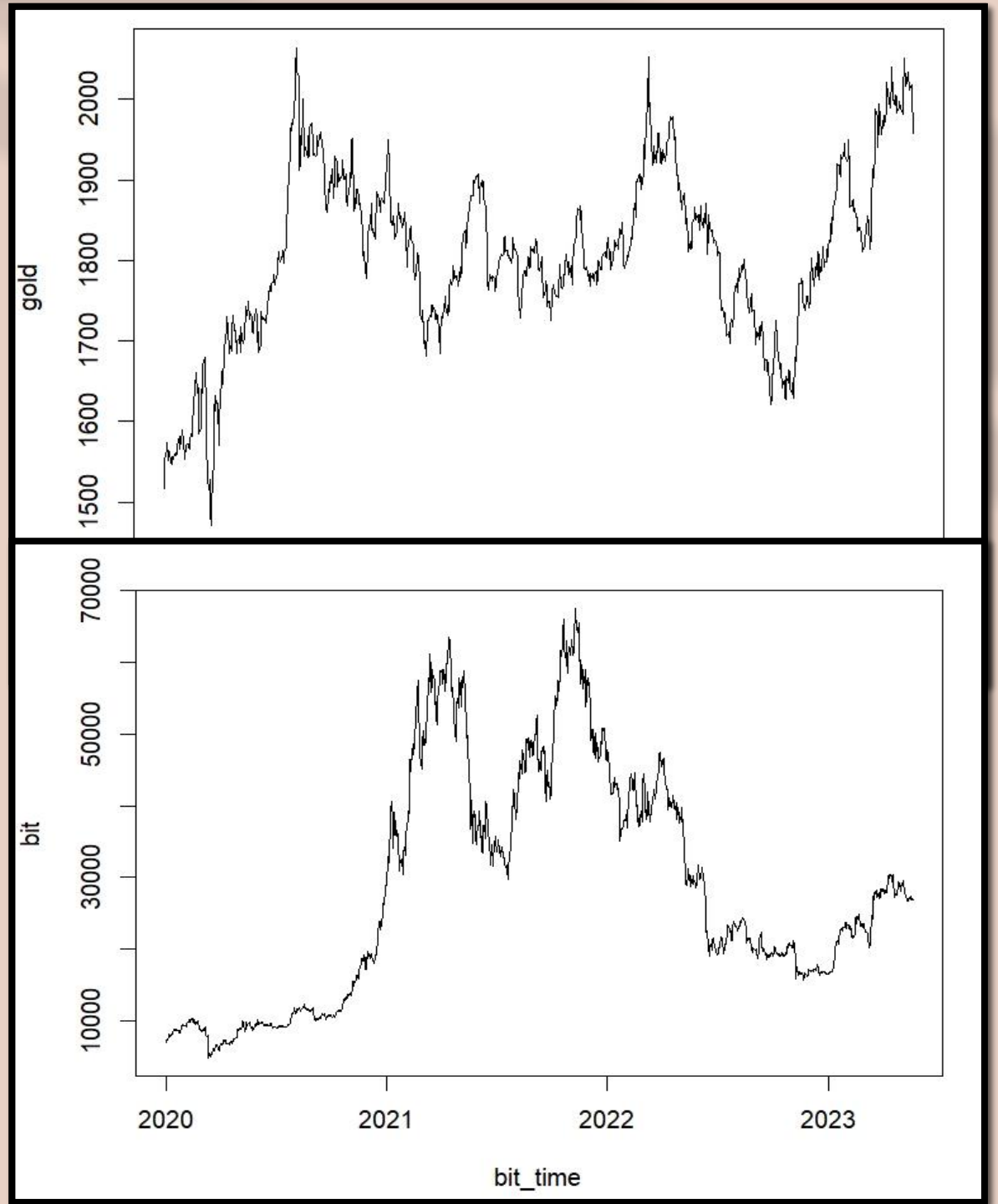
1. https://hk.investing.com/currencies/xau-usd-historical-data
2. https://hk.investing.com/crypto/bitcoin/historical-data

Time Plot (每日收盤價)

黃金 (上) 比特幣 (下)

時間
2020年01月01日
-
(比特幣)
2023年05月21日
共 1237 筆

(黃金)
2023年05月19日
共 883 筆

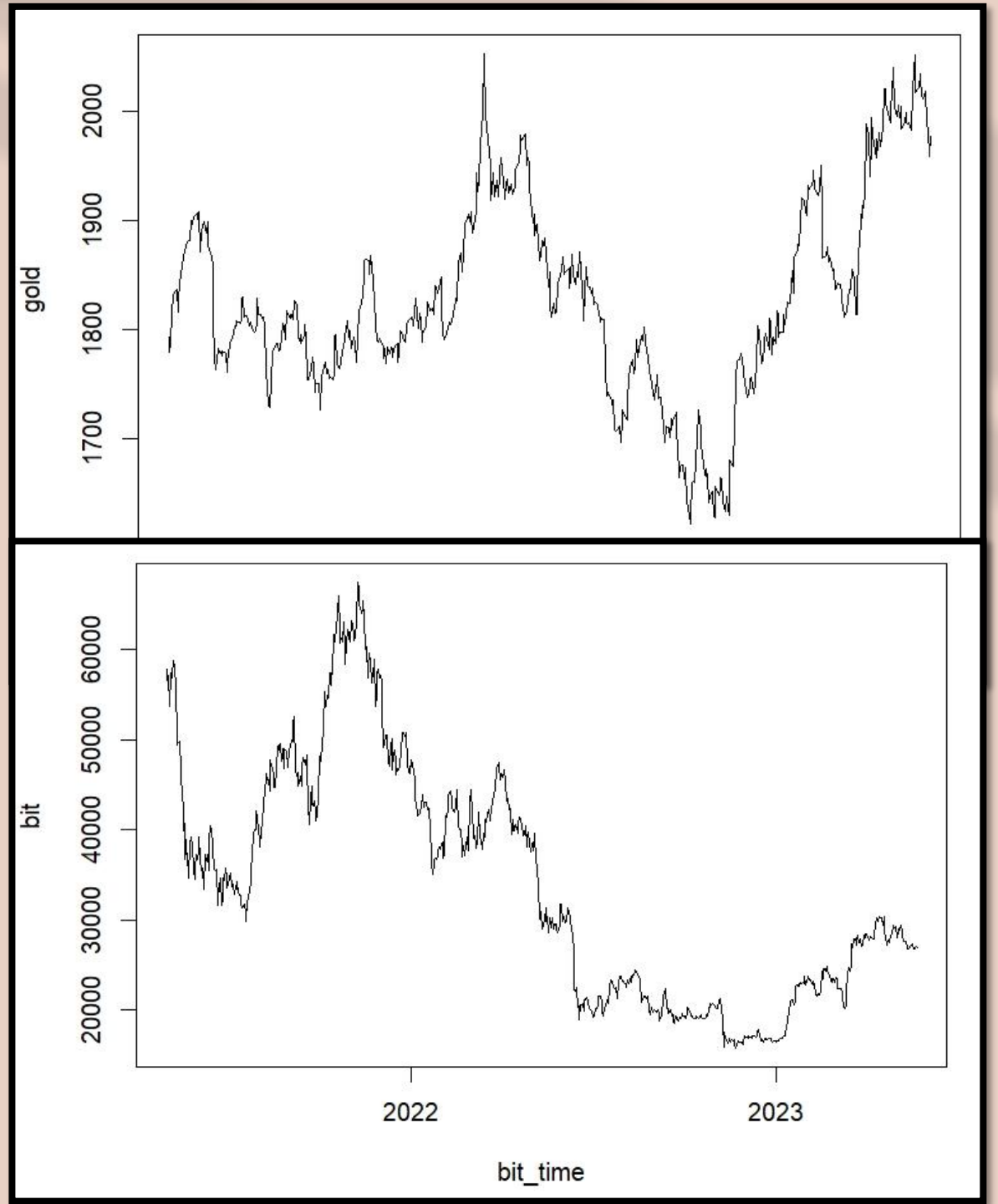


Time Plot (每日收盤價)

黃金 (上) 比特幣 (下)

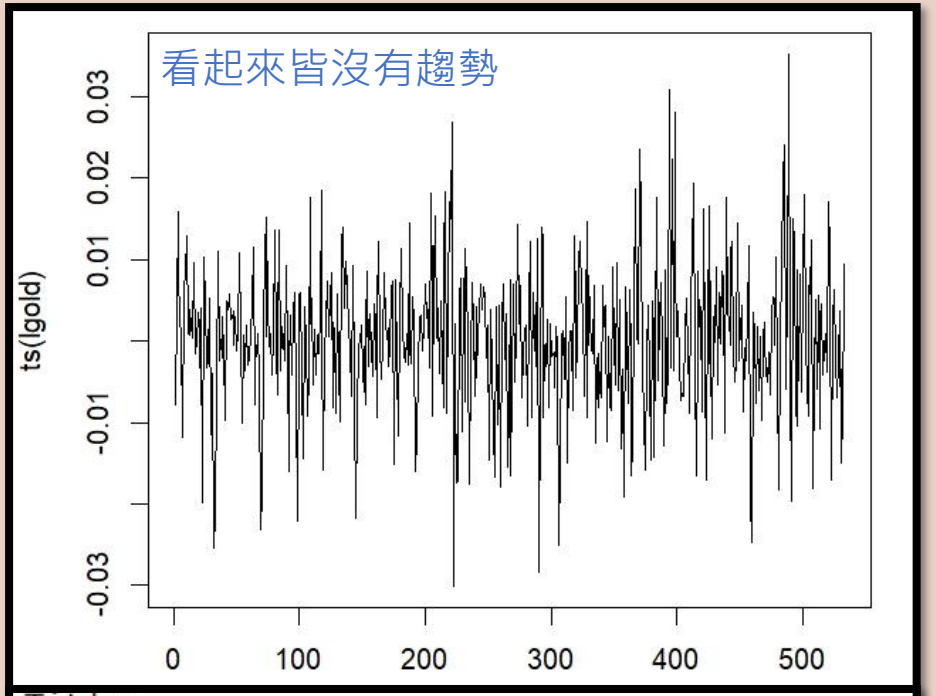
時間
2021年05月01日
-
(比特幣)
2023年05月21日
共 751 筆

(黃金)
2023年05月19日
共 534 筆

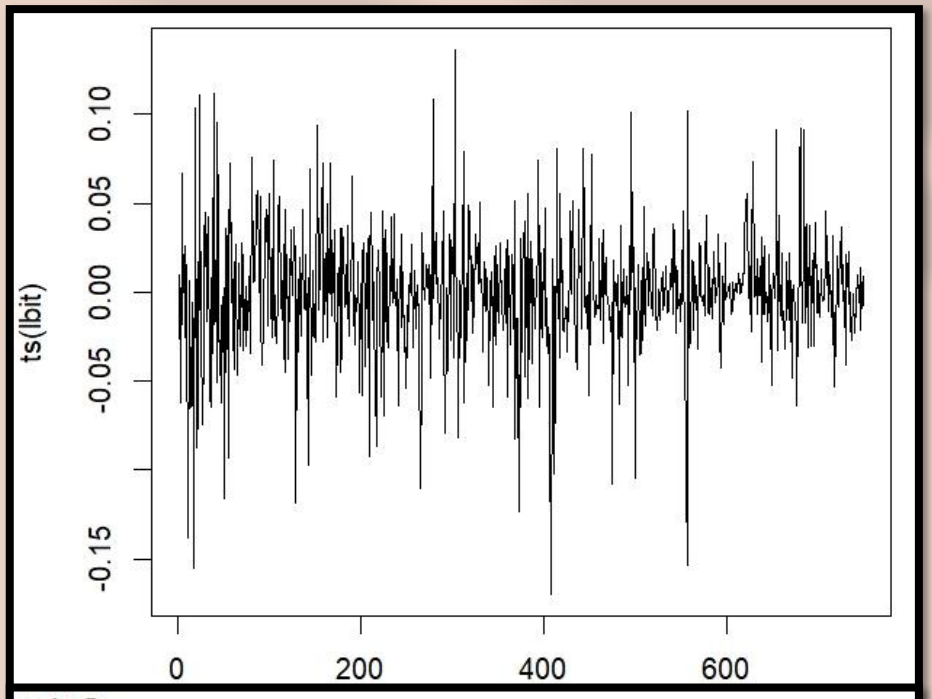


Time Plot (日對數報酬率)

黃金 (左) 比特幣 (右)




```
Title:
 Augmented Dickey-Fuller Test

Test Results:
  PARAMETER:
    Lag Order: 10
  STATISTIC:
    Dickey-Fuller: -7.1441
  P VALUE:
    0.01
```

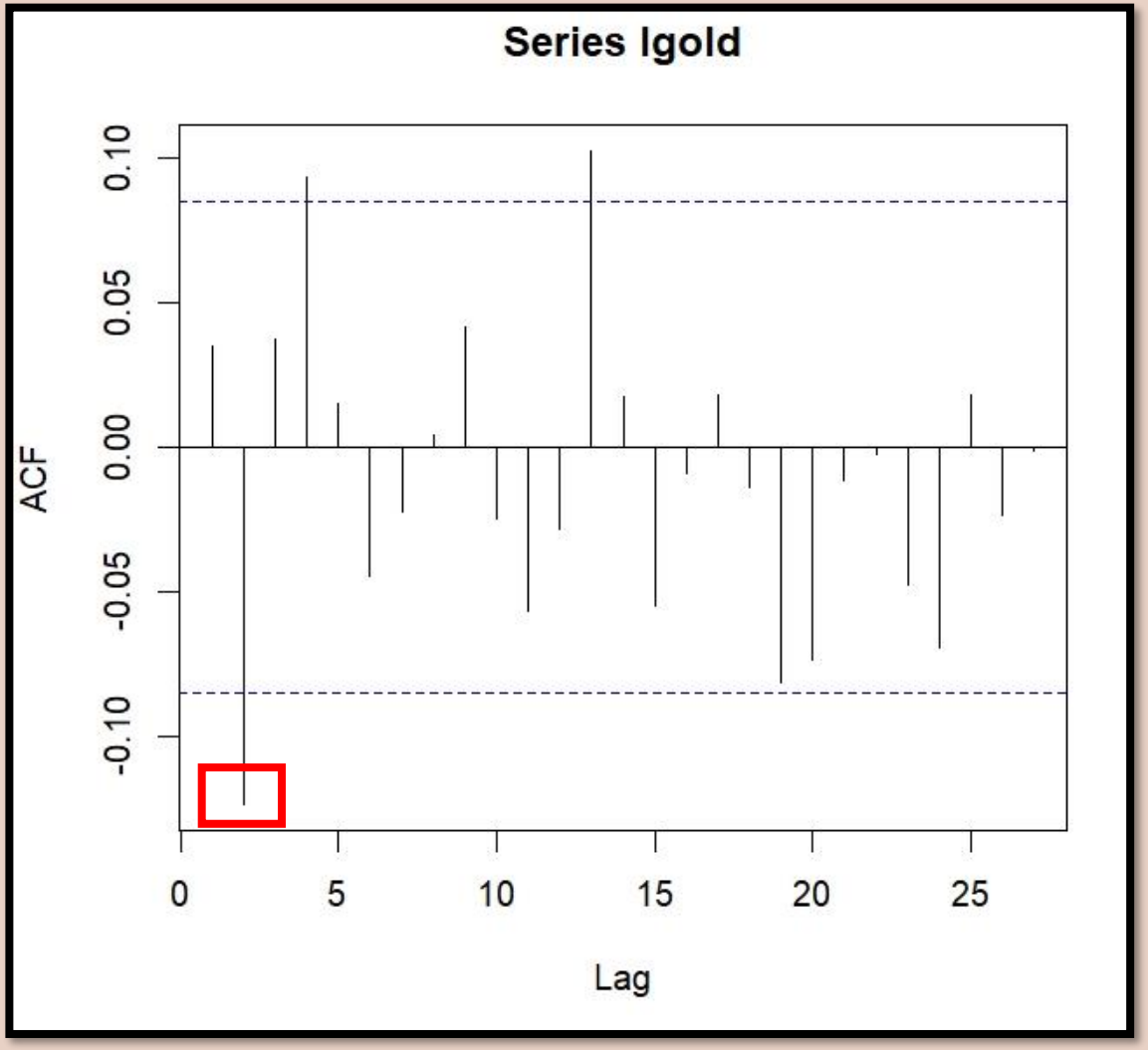


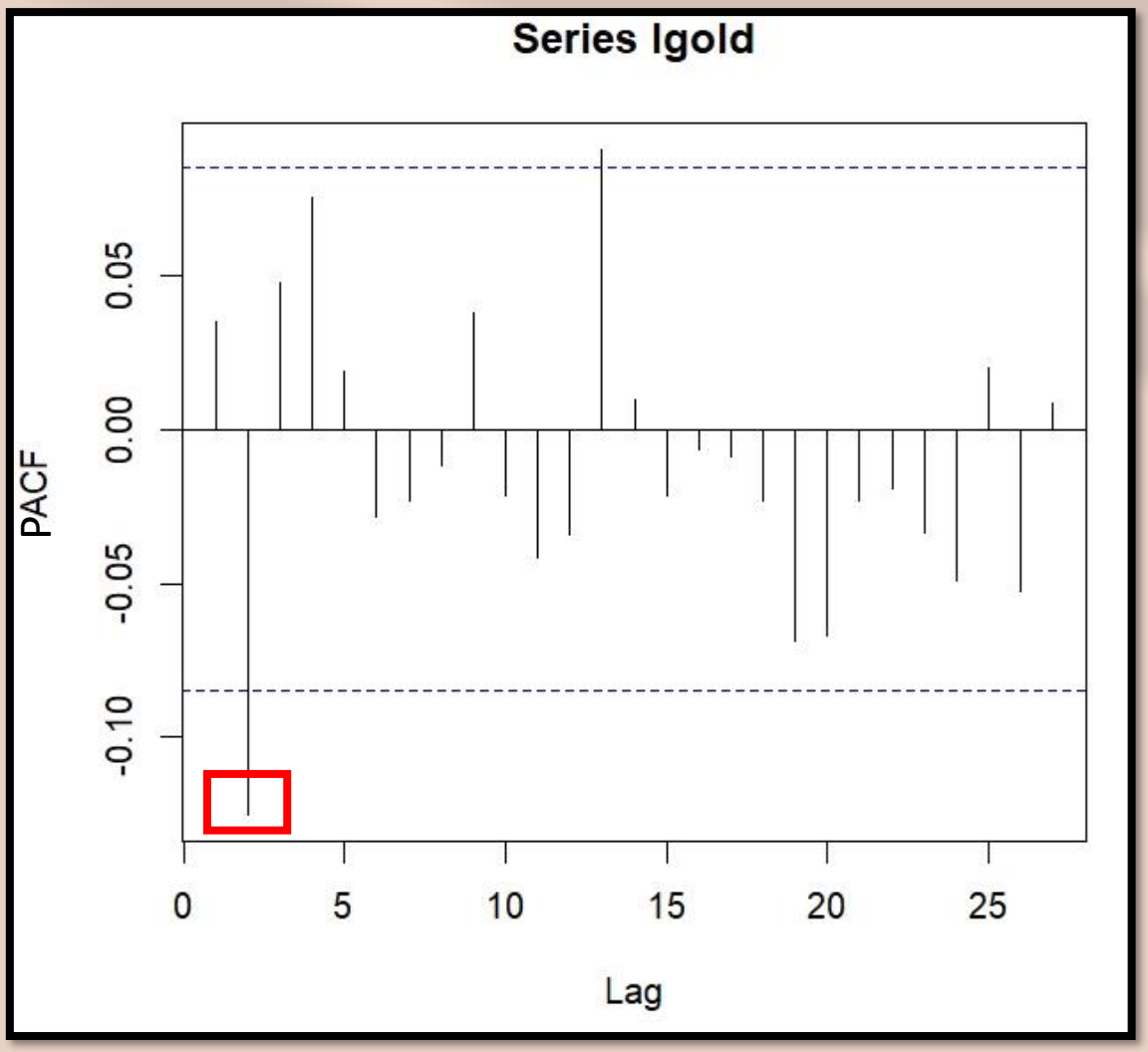

```
Title:
 Augmented Dickey-Fuller Test

Test Results:
  PARAMETER:
    Lag Order: 10
  STATISTIC:
    Dickey-Fuller: -8.2
  P VALUE:
    0.01
```

ADF Test : 皆不用差分

3. 模型挑選

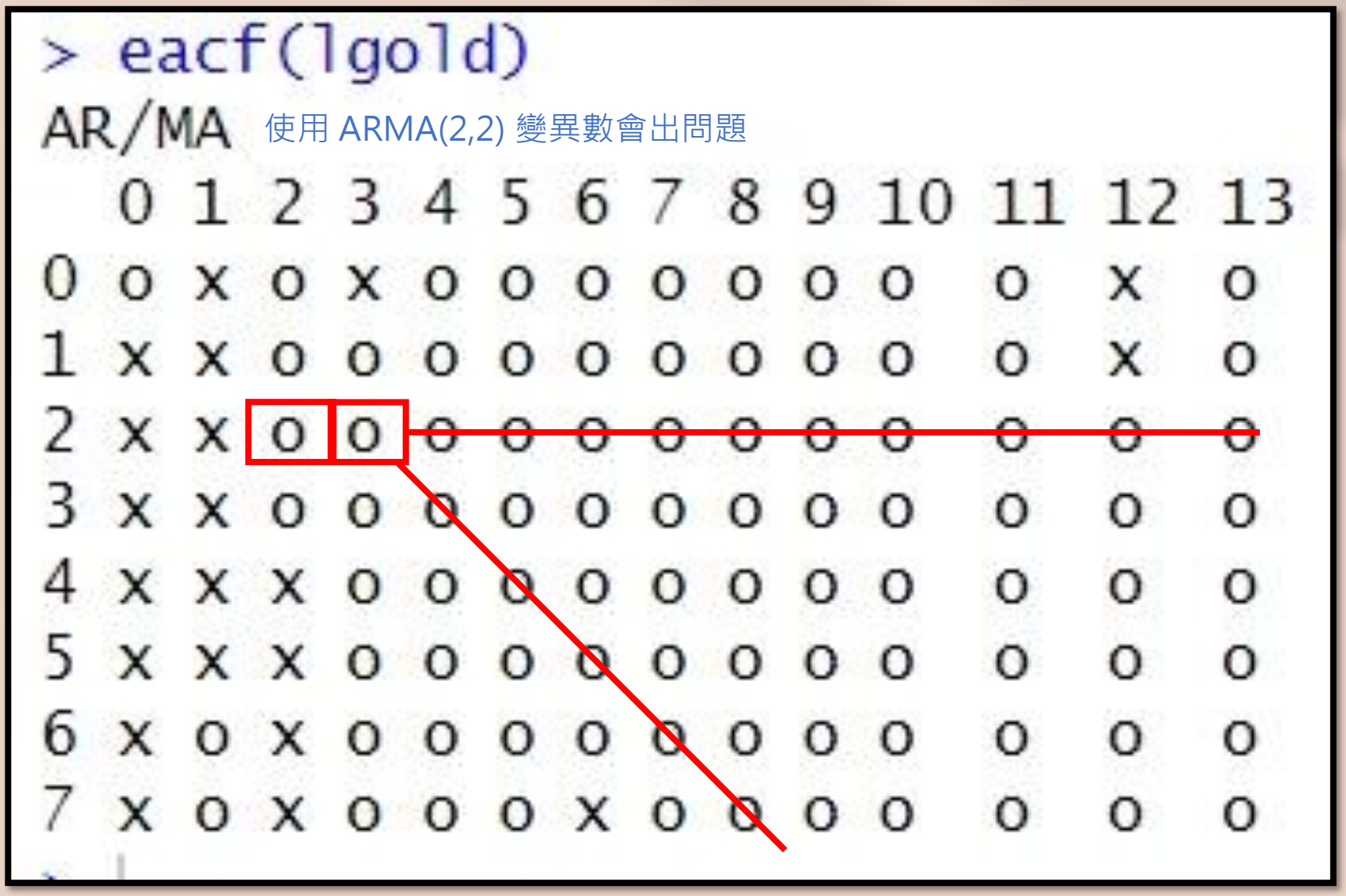
黃金兩年 ACF & PACF





黃金兩年 EACF

選擇 ARMA(2,3)



ARMA(2,3)

ARMA(3,2) AIC 較高

```
Call:
arima(x = lgold, order = c(2, 0, 3))

Coefficients:
         ar1      ar2      ma1     ma2     ma3  intercept
      0.3417  -0.9149  -0.2995  0.8349  0.0832      2e-04
s.e.  0.0465   0.0817   0.0638  0.1079  0.0501      4e-04

sigma^2 estimated as 7.749e-05:  log likelihood = 1766.08,  aic = -3520.16
```

Fixed 參數，變異數出問題且 AIC 還上升，用原 Model

```
> arima_gold1

Call:
arima(x = lgold, order = c(2, 0, 2))

Coefficients:
          ar1      ar2     ma1     ma2  intercept
      -0.0377  -0.5188  0.0644  0.3946      2e-04
s.e.      NaN      NaN     NaN     NaN      4e-04

sigma^2 estimated as 7.838e-05:  log likelihood = 1763.14,  aic = -3516.28
```

CHECK MODEL
(Ljung Box Test)

- Mean equation

```
> Box.test(arima_gold1$residuals,lag=12,type="Ljung",fitdf=5)

        Box-Ljung test

data:  arima_gold1$residuals
X-squared = 4.0206, df = 7, p-value = 0.7774
```

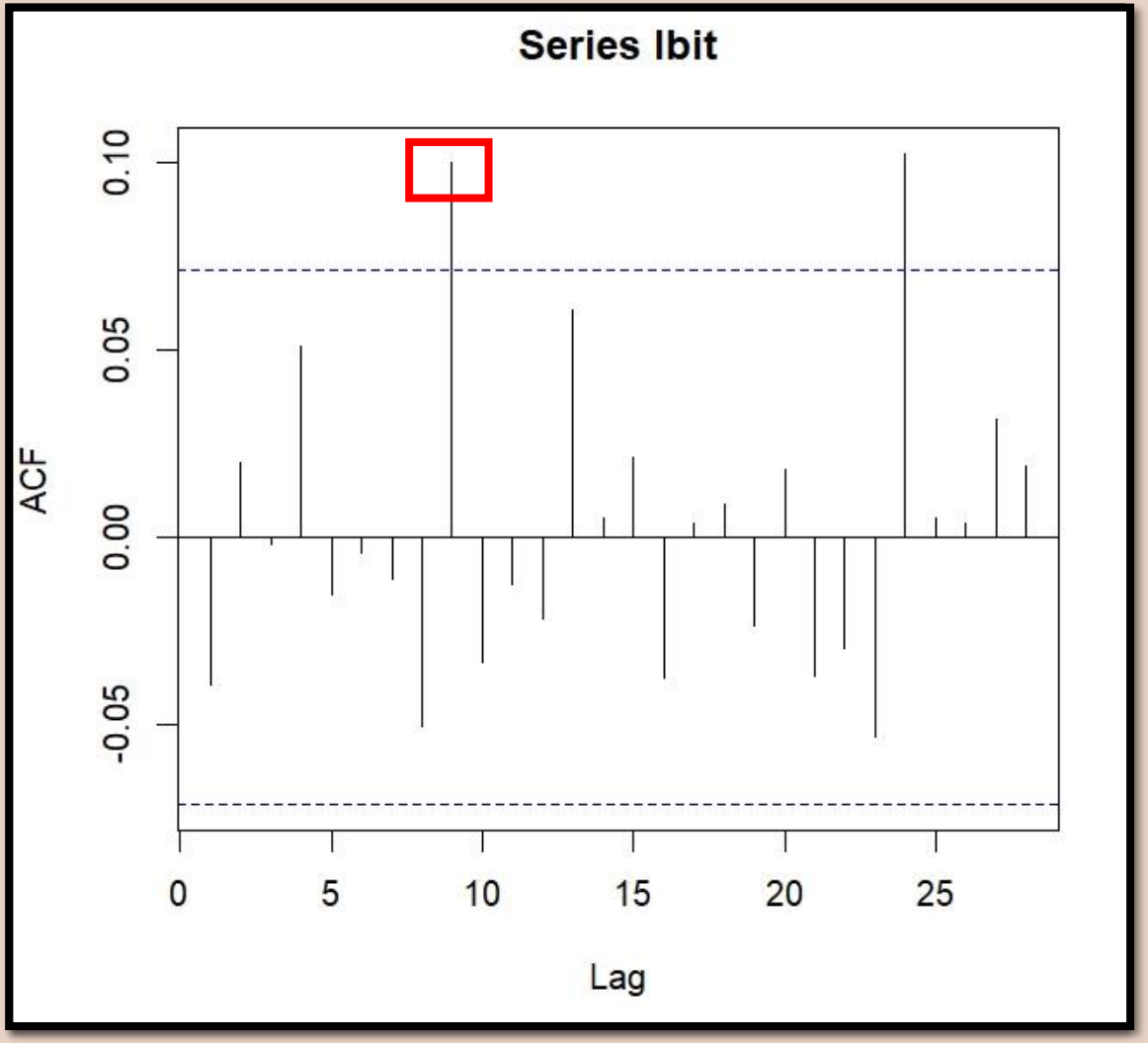
Series uncorrelation

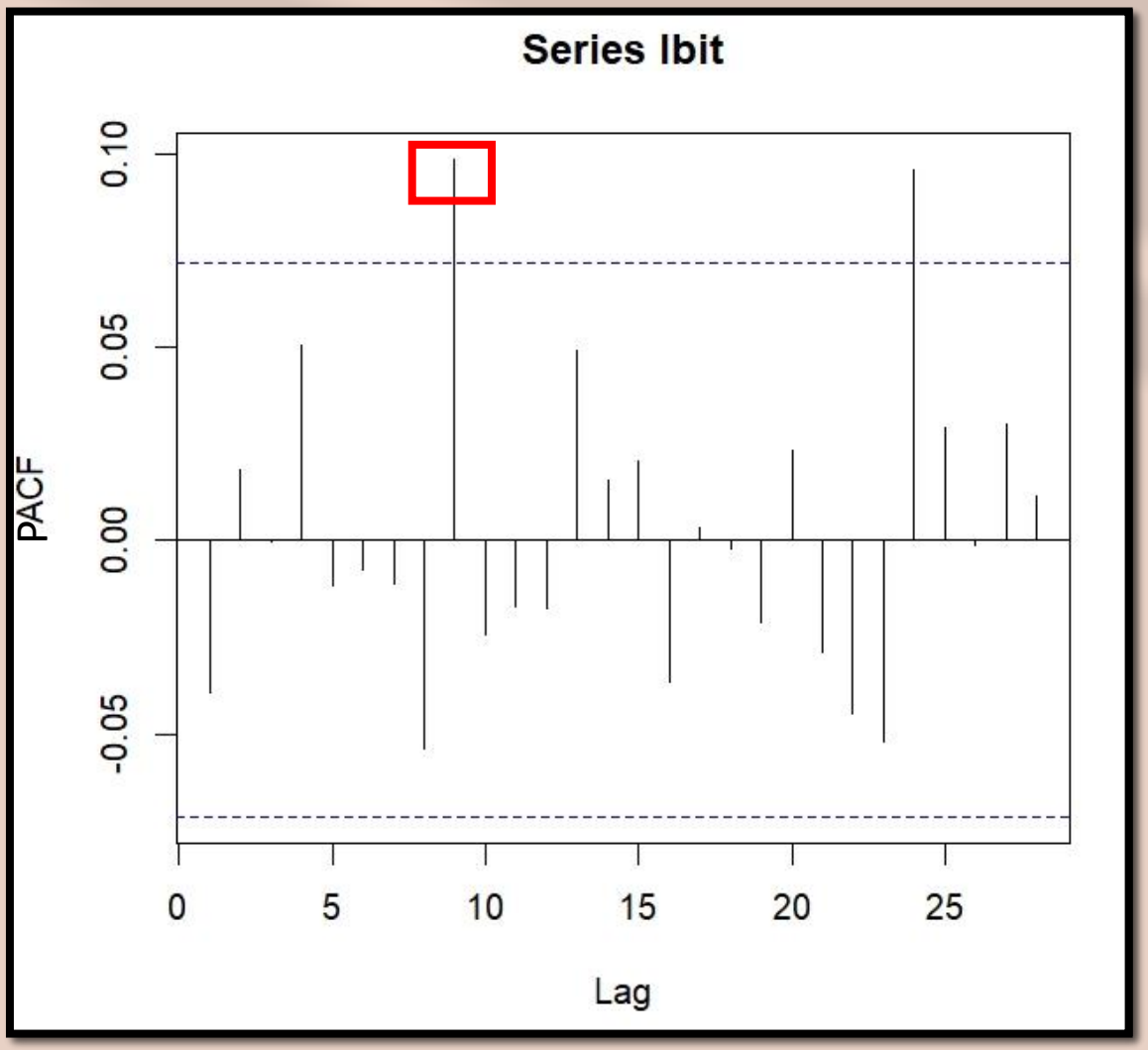
- Variance equation : exist ARCH effect ?

```
> Box.test(arima_gold1$residuals^2,lag=12,type="Ljung")

        Box-Ljung test

data:  arima_gold1$residuals^2
X-squared = 16.734, df = 12, p-value = 0.1599
```

Not conditional heteroscedastic

比特幣兩年 ACF & PACF





比特幣兩年 EACF

選擇 ARMA(3,3)

```
> eacf(lbit)
AR/MA
  0 1 2 3 4 5 6 7 8 9 10 11 12 13
0 o o o o o o o o x o o  o  o  o
1 x o o o o o o o x o o  o  o  o
2 o o o o o o o o o o o  o  o  o
3 o x x o o o o o o o o  o  o  o
4 x x x x o o o o o o o  o  o  o
5 x o o x x o o o o o o  o  o  o
6 x o o x x x o o o o o  o  o  o
7 x o x x o o o o o o o  o  o  o
```

使用 ARMA(2,2) 變異數會出問題

ARMA(3,3)

```
Call:
arima(x = lbit, order = c(3, 0, 3))

Coefficients:
          ar1      ar2      ar3     ma1     ma2     ma3  intercept
      -1.4979  -1.0233  -0.1495  1.4620  0.9729  0.0894    -0.0010
s.e.   0.4418   0.6719   0.4133  0.4396  0.6656  0.4140     0.0012

sigma^2 estimated as 0.00122:  log likelihood = 1451.63,  aic = -2889.27
```

Fixed 參數

```
Call:
arima(x = lbit, order = c(3, 0, 3), transform.pars = F, fixed = c(NA, NA, 0,
    NA, 0, 0, 0))

Coefficients:
          ar1     ar2  ar3     ma1  ma2  ma3  intercept
      -0.6131  0.0003    0  0.5756    0    0          0
s.e.   0.3568  0.0430    0  0.3547    0    0          0

sigma^2 estimated as 0.001228:  log likelihood = 1449.32,  aic = -2892.63
```

CHECK MODEL
(Ljung Box Test)

- Mean equation

```
> Box.test(arima_bit2$residuals,lag=12,type="Ljung",fitdf=4)

        Box-Ljung test

data:  arima_bit2$residuals
X-squared = 12.003, df = 8, p-value = 0.1511
```

Series uncorrelation

- Variance equation : exist ARCH effect ?

```
> Box.test(arima_bit2$residuals^2,lag=12,type="Ljung")

        Box-Ljung test

data:  arima_bit2$residuals^2
X-squared = 35.403, df = 12, p-value = 0.0004039
```

Have conditional heteroscedastic

Deal ARCH effect

殘差平方的EACF

選擇 GARCH(2,3)

```
> eacf(arima_bit2$residuals^2)
AR/MA
  0 1 2 3 4 5 6 7 8 9 10 11 12 13
0 x o o x o o x o o o o  o  o  x
1 x o o x o o x o o o o  o  o  x
2 x o o o o o o o o o o  o  o  o
3 x x x o o o o o o o o  o  o  o
4 x x x o o o o o o o o  o  o  o
5 x x x x x o o o o o o  o  o  o
6 x x x x x x o o o o o  o  o  o
7 x x x x x o x o o o o  o  o  o
```

使用 GARCH(2,2) 會出現收斂問題

ARMA(3,3) + GARCH(2,3)

```
*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(2,3)
Mean Model       : ARFIMA(3,0,3)
Distribution     : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error     t value Pr(>|t|)
mu      -0.000466    0.001167   -0.39909 0.689825
ar1     -1.387470    0.003968 -349.68977 0.000000
ar2     -0.835926    0.019452  -42.97342 0.000000
ar3      0.090853    0.014050    6.46641 0.000000
ma1      1.394211    0.000657 2123.37822 0.000000
ma2      0.841840    0.000199 4222.46617 0.000000
ma3     -0.099672    0.000875 -113.84805 0.000000
omega    0.000111    0.000069    1.61806 0.105650
alpha1   0.165029    0.040811    4.04377 0.000053
alpha2   0.000000    0.054267    0.00000 1.000000
beta1    0.180109    0.157571    1.14303 0.253026
beta2    0.000000    0.147845    0.00000 1.000000
beta3    0.566423    0.114818    4.93323 0.000001
```

有不顯著的參數外
Nyblom stability test 不完全通過
其他檢定全數通過

```
Adjusted Pearson Goodness-of-Fit Test:
------------------------------------
  group statistic p-value(g-1)
1    20     90.53    2.668e-11
2    30    101.68    5.259e-10
3    40    104.83    6.119e-08
4    50    119.20    8.802e-08
```

p-value 皆小於 0.05

```
Information Criteria
------------------------------------

Akaike       -3.9152
Bayes        -3.8351
Shibata      -3.9158
Hannan-Quinn -3.8843

Weighted Ljung-Box Test on Standardized Residuals
------------------------------------
                        statistic p-value
Lag[1]                     0.1668  0.6830
Lag[2*(p+q)+(p+q)-1][17]   5.4649  1.0000
Lag[4*(p+q)+(p+q)-1][29]  10.4576  0.9555
d.o.f=6
H0 : No serial correlation

Weighted Ljung-Box Test on Standardized Squared Residuals
------------------------------------
                        statistic p-value
Lag[1]                   0.004106  0.9489
Lag[2*(p+q)+(p+q)-1][14] 1.515000  0.9974
Lag[4*(p+q)+(p+q)-1][24] 7.682032  0.8944
d.o.f=5

Weighted ARCH LM Tests
------------------------------------
            Statistic Shape Scale P-Value
ARCH Lag[6]    0.2767 0.500 2.000  0.5989
ARCH Lag[8]    0.8098 1.480 1.774  0.8166
ARCH Lag[10]   1.2465 2.424 1.650  0.9017
```

p-value 皆大於 0.05

```
Nyblom stability test
------------------------------------
Joint Statistic:  2.8258
Individual Statistics:
mu      0.16467
ar1     0.14390
ar2     0.07463
ar3     0.04429
ma1     0.04023
ma2     0.03206
ma3     0.06804
omega   0.63371
alpha1  0.32505
alpha2  0.62964
beta1   0.72054
beta2   0.64421
beta3   0.74130

Asymptotic Critical Values (10% 5% 1%)
Joint Statistic:          2.89 3.15 3.69
Individual Statistic:     0.35 0.47 0.75

Sign Bias Test
------------------------------------
                    t-value   prob sig
Sign Bias            0.9411 0.3470
Negative Sign Bias   0.6210 0.5348
Positive Sign Bias   1.2001 0.2305
Joint Effect         1.8268 0.6091
```

模型的參數
會隨時間改變
並不是常數

優先刪除 alpha2、beta2
(p-value 已經到達 1)

```
*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(2,3)
Mean Model       : ARFIMA(3,0,3)
Distribution     : norm

Optimal Parameters
-----------------------------------
        Estimate  Std. Error     t value Pr(>|t|)
mu     -0.000674    0.000011   -58.8068 0.000000
ar1     0.470836    0.000023 20483.3272 0.000000
ar2    -0.052249    0.000032 -1608.6411 0.000000
ar3    -0.742407    0.000195 -3813.9442 0.000000
ma1    -0.477387    0.000055 -8674.2320 0.000000
ma2     0.041745    0.000023  1804.7596 0.000000
ma3     0.801537    0.000070 11479.9602 0.000000
omega   0.000101    0.000045     2.2260 0.026015
alpha1  0.147600    0.037334     3.9535 0.000077
alpha2  0.000000          NA         NA       NA
beta1   0.167392    0.063999     2.6155 0.008909
beta2   0.000000          NA         NA       NA
beta3   0.600206    0.082865     7.2432 0.000000
```

所有參數皆顯著
其他檢定全數通過

```
Nyblom stability test
-----------------------------------
Joint Statistic:  8.6698
Individual Statistics:
mu      0.009012
ar1     0.004989
ar2     0.018436
ar3     0.015096
ma1     0.016920
ma2     0.008352
ma3     0.017739
omega   0.518181
alpha1  0.306732
beta1   0.607664
beta3   0.614394

Asymptotic Critical Values (10% 5% 1%)
Joint Statistic:          2.49 2.75 3.27
Individual Statistic:     0.35 0.47 0.75

Sign Bias Test
-----------------------------------
                    t-value   prob sig
Sign Bias            0.5181 0.6046
Negative Sign Bias   0.6377 0.5239
Positive Sign Bias   0.7809 0.4351
Joint Effect         1.0815 0.7815
```

Nyblom stability test
嚴重不通過

考慮 GARCH-M

(mean equation 加入風險是否有幫助)

```
*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(2,3)
Mean Model       : ARFIMA(3,0,3)
Distribution     : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error     t value Pr(>|t|)
mu      0.001373    0.003059     0.44880 0.653573
ar1     1.034815    0.038724    26.72278 0.000000
ar2    -1.220797    0.027308   -44.70535 0.000000
ar3     0.461944    0.042680    10.82332 0.000000
ma1    -1.049685    0.003174  -330.69612 0.000000
ma2     1.231866    0.000093 13175.94334 0.000000
ma3    -0.441411    0.014795   -29.83442 0.000000
archm  -1.671435    2.693645    -0.62051 0.534922
omega   0.000121    0.000084     1.44012 0.149834
alpha1  0.173907    0.041703     4.17010 0.000030
alpha2  0.000000    0.067901     0.00000 1.000000
beta1   0.151044    0.209942     0.71945 0.471861
beta2   0.000000    0.173453     0.00000 1.000000
beta3   0.577725    0.116132     4.97473 0.000001
```

```
Nyblom stability test
-------------------------------------
Joint Statistic:  3.2414
Individual Statistics:
mu      0.09558
ar1     0.14428
ar2     0.22188
ar3     0.03515
ma1     0.17624
ma2     0.20924
ma3     0.03089
archm   0.09743
omega   0.67569
alpha1  0.35419
alpha2  0.65283
beta1   0.84147
beta2   0.77509
beta3   0.85826

Asymptotic Critical Values (10% 5% 1%)
Joint Statistic:          3.08 3.34 3.9
Individual Statistic:     0.35 0.47 0.75

Sign Bias Test
-------------------------------------
                    t-value   prob sig
Sign Bias             1.602 0.1097
Negative Sign Bias    1.168 0.2431
Positive Sign Bias    1.441 0.1500
Joint Effect          3.616 0.3060
```

不顯著的參數外

Nyblom stability test 不完全通過

其他檢定全數通過

更新 GARCH-M

(mean equation 加入風險是否有幫助)

```
*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(2,3)
Mean Model       : ARFIMA(3,0,3)
Distribution     : norm

Optimal Parameters
-----------------------------------
        Estimate  Std. Error     t value Pr(>|t|)
mu      0.000000          NA          NA       NA
ar1    -0.437886    0.011615   -37.70042 0.000000
ar2    -0.405643    0.010041   -40.40030 0.000000
ar3    -0.950290    0.008385  -113.33262 0.000000
ma1     0.408007    0.001635   249.51148 0.000000
ma2     0.373328    0.002338   159.67595 0.000000
ma3     0.964283    0.000023 41301.95355 0.000000
archm  -0.526916    1.002807    -0.52544 0.599277
omega   0.000118    0.000048     2.45121 0.014238
alpha1  0.170426    0.040856     4.17135 0.000030
alpha2  0.000000          NA          NA       NA
beta1   0.153885    0.060312     2.55148 0.010727
beta2   0.000000          NA          NA       NA
beta3   0.581108    0.078217     7.42942 0.000000
```

關鍵 archm 係數不顯著!!

```
Nyblom stability test
-----------------------------------
Joint Statistic:  2.4569
Individual Statistics:
ar1     0.01321
ar2     0.04445
ar3     0.13135
ma1     0.02792
ma2     0.02883
ma3     0.05305
archm   0.13238
omega   0.64869
alpha1  0.34438
beta1   0.82891
beta3   0.83523

Asymptotic Critical Values (10% 5% 1%)
Joint Statistic:          2.49 2.75 3.27
Individual Statistic:     0.35 0.47 0.75

Sign Bias Test
-----------------------------------
                    t-value   prob sig
Sign Bias             1.470 0.1420
Negative Sign Bias    1.144 0.2528
Positive Sign Bias    1.424 0.1550
Joint Effect          3.406 0.3332
```

Nyblom stability test 不完全通過
(但比上個模型好)
其他檢定全數通過

考慮 EGARCH
(非線性模型)

```
*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : eGARCH(2,3)
Mean Model       : ARFIMA(3,0,3)
Distribution     : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error     t value Pr(>|t|)
mu     -0.000885    0.000513 -1.7255e+00 0.084434
ar1    -0.681524    0.036078 -1.8890e+01 0.000000
ar2     0.254746    0.037927  6.7167e+00 0.000000
ar3     0.792797    0.048370  1.6390e+01 0.000000
ma1     0.698001    0.030997  2.2518e+01 0.000000
ma2    -0.211405    0.034047 -6.2091e+00 0.000000
ma3    -0.788500    0.000019 -4.1581e+04 0.000000
omega  -0.836482    0.244444 -3.4220e+00 0.000622
alpha1 -0.055853    0.030663 -1.8215e+00 0.068529
alpha2 -0.093085    0.024729 -3.7642e+00 0.000167
beta1   0.392230    0.018690  2.0986e+01 0.000000
beta2  -0.351116    0.022569 -1.5557e+01 0.000000
beta3   0.833442    0.004795  1.7381e+02 0.000000
gamma1  0.355485    0.035575  9.9927e+00 0.000000
gamma2  0.012070    0.024628  4.9009e-01 0.624068
```

```
Nyblom stability test
------------------------------------
Joint Statistic:  3.4534
Individual Statistics:
mu      0.07051
ar1     0.08483
ar2     0.10259
ar3     0.05262
ma1     0.02690
ma2     0.03521
ma3     0.04712
omega   0.47233
alpha1  0.08639
alpha2  0.28092
beta1   0.44557
beta2   0.44126
beta3   0.41382
gamma1  0.18834
gamma2  0.11463

Asymptotic Critical Values (10% 5% 1%)
Joint Statistic:          3.26 3.54 4.07
Individual Statistic:     0.35 0.47 0.75

Sign Bias Test
------------------------------------
                    t-value   prob sig
Sign Bias           0.58501 0.5587
Negative Sign Bias  0.02203 0.9824
Positive Sign Bias  0.80825 0.4192
Joint Effect        0.70095 0.8730
```

不顯著的參數外
Nyblom stability test 不完全通過
其他檢定全數通過

更新 EGARCH
(非線性模型)

```
*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : eGARCH(2,3)
Mean Model       : ARFIMA(3,0,3)
Distribution     : norm

Optimal Parameters
-----------------------------------
        Estimate  Std. Error     t value Pr(>|t|)
mu     -0.000927    0.000243 -3.8196e+00 0.000134
ar1    -1.825788    0.005249 -3.4782e+02 0.000000
ar2    -1.525943    0.007450 -2.0482e+02 0.000000
ar3    -0.374257    0.004160 -8.9961e+01 0.000000
ma1     1.816265    0.000038  4.7925e+04 0.000000
ma2     1.512069    0.000000  3.0556e+06 0.000000
ma3     0.354945    0.000118  3.0040e+03 0.000000
omega  -0.870019    0.046157 -1.8849e+01 0.000000
alpha1 -0.047730    0.006584 -7.2499e+00 0.000000
alpha2 -0.078023    0.006860 -1.1374e+01 0.000000
beta1   0.388594    0.016767  2.3176e+01 0.000000
beta2  -0.362010    0.014680 -2.4661e+01 0.000000
beta3   0.842818    0.000967  8.7155e+02 0.000000
gamma1  0.307633    0.033851  9.0878e+00 0.000000
gamma2  0.000000          NA          NA       NA
```

係數皆顯著!!

```
Nyblom stability test
-----------------------------------
Joint Statistic:  2.4837
Individual Statistics:
mu      0.09787
ar1     0.23672
ar2     0.14337
ar3     0.04752
ma1     0.21015
ma2     0.19019
ma3     0.06409
omega   0.49527
alpha1  0.07976
alpha2  0.28052
beta1   0.46964
beta2   0.46776
beta3   0.44691
gamma1  0.20303

Asymptotic Critical Values (10% 5% 1%)
Joint Statistic:          3.08 3.34 3.9
Individual Statistic:     0.35 0.47 0.75

Sign Bias Test
-----------------------------------
                    t-value   prob sig
Sign Bias            0.6033 0.5465
Negative Sign Bias   0.2522 0.8010
Positive Sign Bias   0.7143 0.4753
Joint Effect         0.5988 0.8967
```

Nyblom stability test 將近全數通過

其他檢定全數通過

4. 預測和結論

一周黃金 & 比特幣預測 (log return)

比特幣

5/22 : -0.0001491
5/23 : -0.0034019
5/24 : 0.0020552
5/25 : -0.0028844
5/26 : -0.0009756

```
> forecast_gold
$pred
Time Series:
Start = 534
End = 538
Frequency = 1
[1]  0.0011922945 -0.0012351568 -0.0002927667  0.0009427153  0.0004084780

$se
Time Series:
Start = 534
End = 538
Frequency = 1
[1] 0.008853509 0.008856559 0.008925516 0.008925908 0.008944804
```

```
*------------------------------------*
*       GARCH Model Forecast         *
*------------------------------------*
Model: eGARCH
Horizon: 5
Roll Steps: 0
Out of Sample: 0

0-roll forecast [T0=1972-01-21 08:00:00]:
        Series   Sigma
T+1 -0.0001491 0.02930
T+2 -0.0034019 0.03044
T+3  0.0020552 0.02252
T+4 -0.0028844 0.02677
T+5 -0.0009756 0.03299
```

黃金

5/22 : 0.0011922945
5/23 : -0.0012351568
5/24 : -0.0002927667
5/25 : 0.0009427153
5/26 : 0.0004084780

比較基準：美國兩年期國債債券報酬率

美國二年期國債債券報酬率歷史數據

時間範圍:

每天

下載數據

2023-05-04 - 2023-06-05

日期	收市	開市	高	低	升跌 (%)
2023-6-2	4.503	4.347	4.528	4.331	+3.69%
2023-6-1	4.343	4.394	4.463	4.316	-1.50%
2023-5-31	4.409	4.463	4.465	4.363	-1.15%
2023-5-30	4.460	4.599	4.603	4.444	-3.06%
2023-5-29	4.601	4.634	4.641	4.576	-0.71%
2023-5-28	4.634	4.606	4.655	4.606	+1.44%
2023-5-26	4.568	4.541	4.639	4.481	+0.69%
2023-5-25	4.537	4.378	4.539	4.367	+3.64%
2023-5-24	4.378	4.277	4.392	4.248	+1.33%
2023-5-23	4.320	4.322	4.408	4.311	+0.01%
2023-5-22	4.320	4.249	4.345	4.222	+0.96%
2023-5-19	4.279	4.256	4.349	4.196	+0.43%
2023-5-18	4.260	4.152	4.281	4.131	+2.40%
2023-5-17	4.160	4.088	4.177	4.055	+1.86%
2023-5-16	4.084	4.010	4.120	3.962	+1.84%
2023-5-15	4.010	3.993	4.031	3.964	+0.48%
2023-5-12	3.991	3.889	4.008	3.874	+2.36%
2023-5-11	3.899	3.918	3.941	3.810	-0.27%
2023-5-10	3.910	4.026	4.089	3.874	-2.89%

資料來源：美國二年期國債債券歷史數據 - Investing.com

債券報酬率 Model

一. Mean equation

1. ARMA(4,4)

二. Variance equation

1. GARCH : Adjusted Pearson Goodness-of-Fit Test 出問題
2. EGARCH : 沒有改善，Sign Bias Test 也不通過
3. TGARCH : 除了 係數 omega 不顯著(0.132567)，其他都沒問題，AIC : -3.7641
4. 更新TGARCH : Adjusted Pearson Goodness-of-Fit Test 不通過，AIC : -3.7478

債券報酬率 Model : ARMA(4,4) + 原 TGARCH

一周預測 (log return)

```
> forecast_u

*-----------------------------------*
*       GARCH Model Forecast        *
*-----------------------------------*
Model: gjrGARCH
Horizon: 5
Roll Steps: 0
Out of Sample: 0

0-roll forecast [T0=1971-06-16 08:00:00]:
       Series   Sigma
T+1 -0.001204 0.05213
T+2  0.004122 0.04432
T+3 -0.015745 0.05179
T+4 -0.006634 0.04465
T+5  0.009806 0.05148
```

債券

5/22 : -0.001204

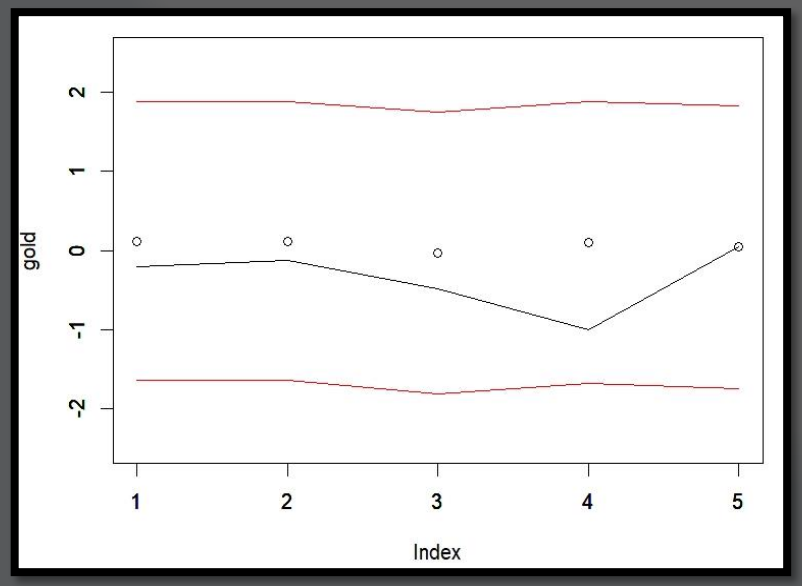
5/23 : 0.004122

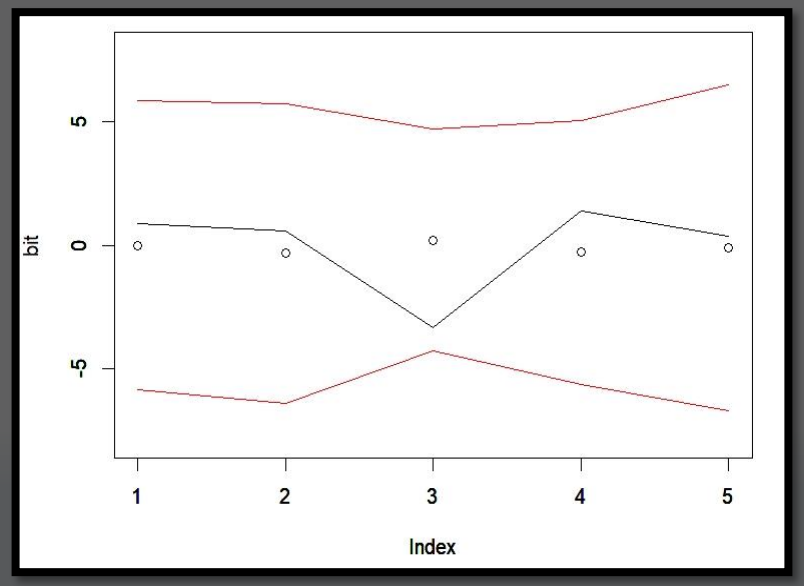
5/24 : -0.015745

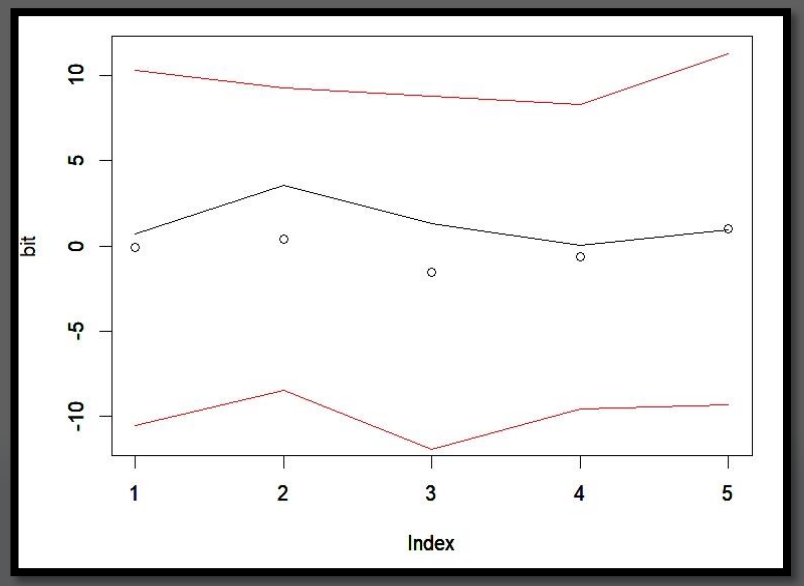
5/25 : -0.006634

5/26 : 0.009806

信賴區間與實際值
(點:預測/黑:實際/紅:信賴區間)







黃金、比特幣、債券 (左至右) 皆在信賴區間內

投資組合權重

```
> pergold
Time Series:
Start = 534
End = 538
Frequency = 1
[1] 0.9949113 0.8882424 1.0000000 0.8922525 0.9704274
```

$$\text{黃金權重} = \frac{\left(\frac{\text{黃金收益率}}{\text{波動率}}\right)}{\left(\frac{\text{黃金收益率}}{\text{波動率}} + \frac{\text{比特幣收益率}}{\text{波動率}}\right)}$$

比特幣權重 = 1 - 黃金權重

```
> perbit
Time Series:
Start = 534
End = 538
Frequency = 1
[1] 0.005088737 0.111757556 0.000000000 0.107747479 0.029572598
```

(權重)	黃金	比特幣
5/22 :	0.995	0.005
5/23 :	0.888	0.112
5/24 :	1.000	0.000
5/25 :	0.892	0.108
5/26 :	0.970	0.030

投資組合 (log return預測值)

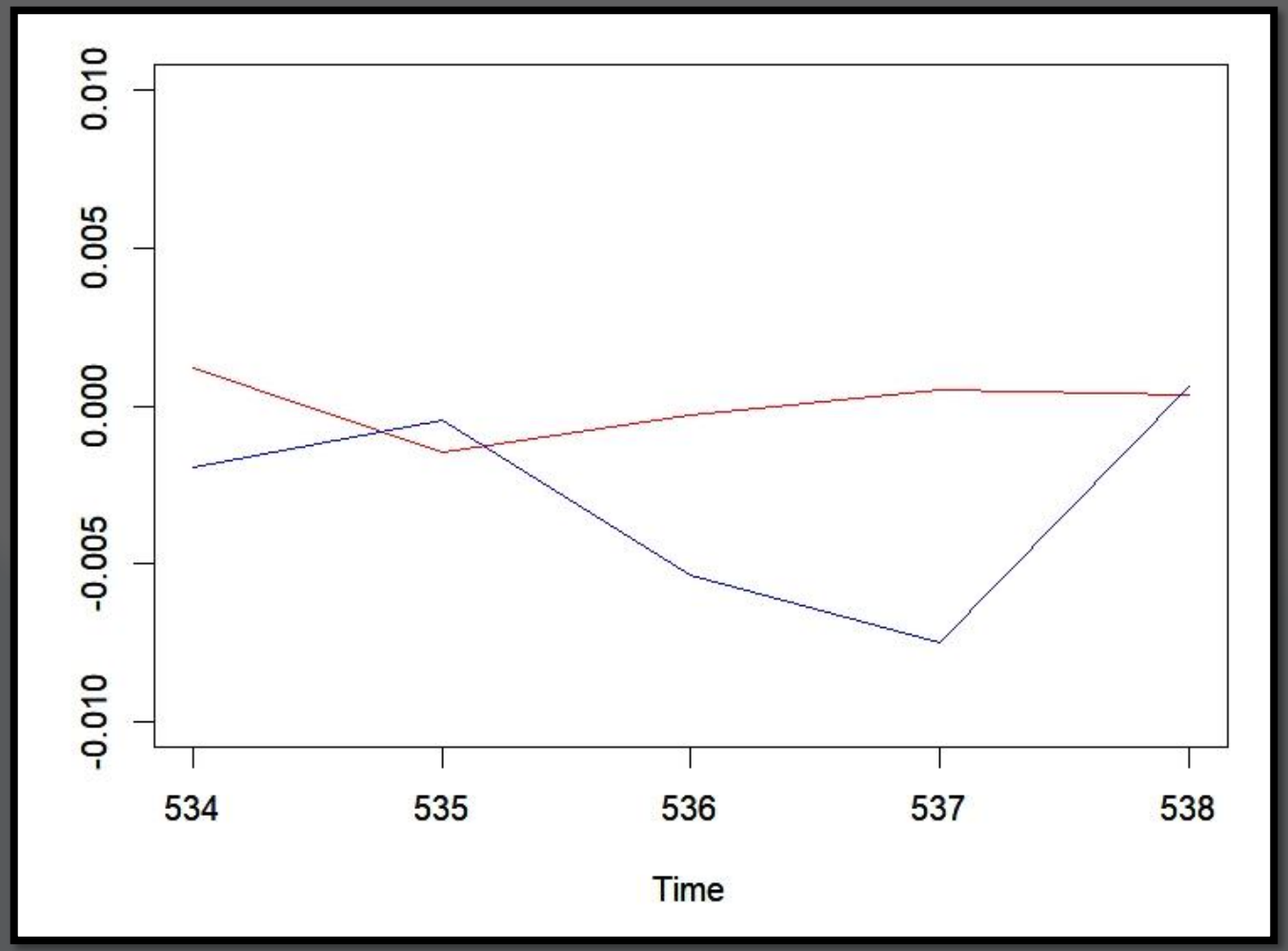
黃金權重*黃金預測報酬率+比特幣權重*比特幣預測報酬率

```
> bindrt
Time Series:
Start = 534
End = 538
Frequency = 1
[1]  0.0011854685 -0.0014773067 -0.0002927667  0.0005303533  0.0003675473
```

黃金權重*黃金實際報酬率+比特幣權重*比特幣實際報酬率

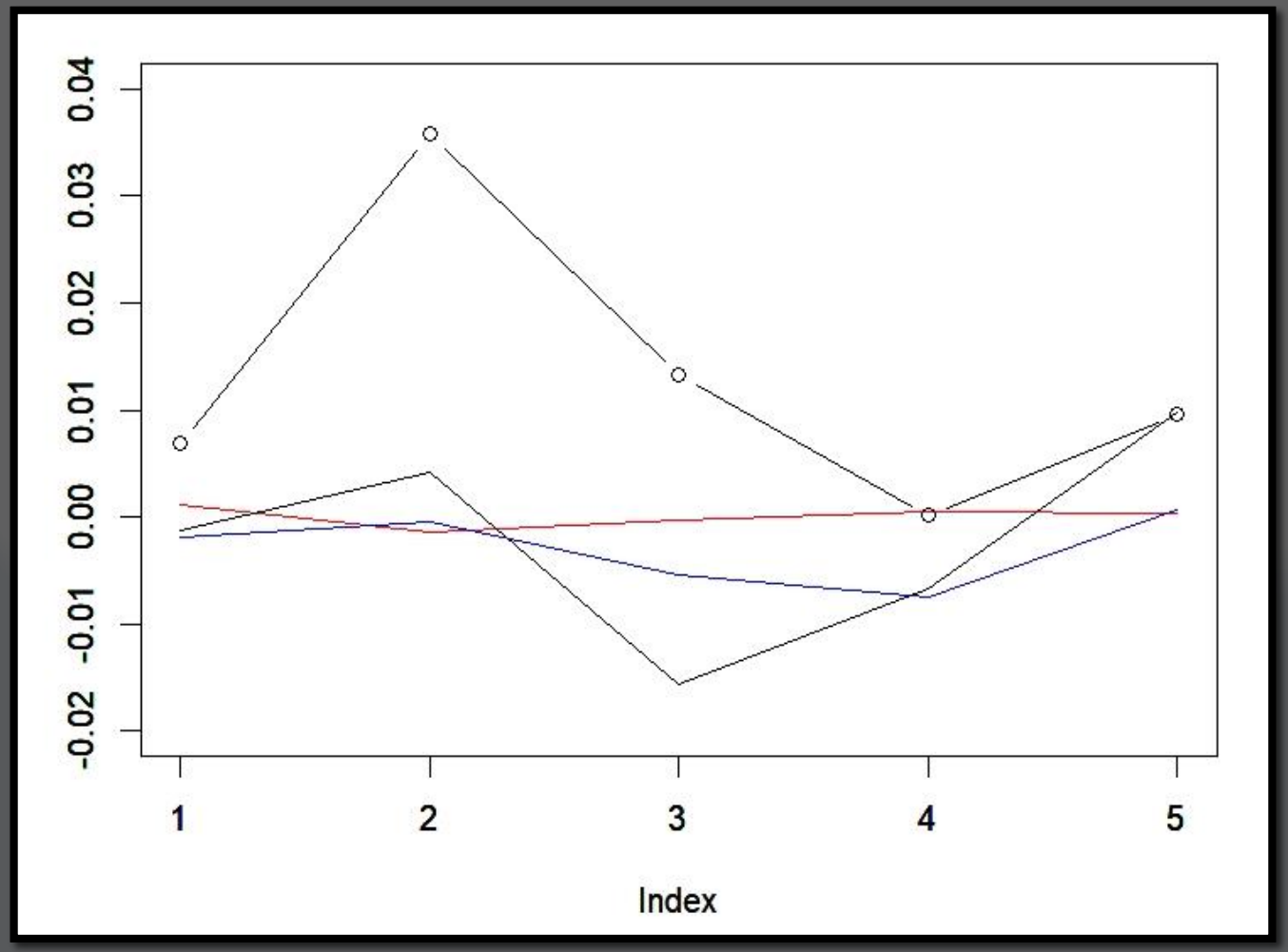
```
> bindrt_real
Time Series:
Start = 534
End = 538
Frequency = 1
[1] -0.0019467256 -0.0004424345 -0.0053603229 -0.0074800610  0.0005913626
```

投資組合
(紅:預測值/藍:實際值)



投資組合

(紅:預測值/藍:實際值/黑實:債券預測/黑虛:債券實際)



結論

1. 疫情長期下來對黃金跟比特幣還是有正面影響的
   - 對比特幣後期影響較小，因為有比特幣的交易所倒閉
2. 價格不適合做預測
   - 長記憶的黃金還不錯，短記憶比特幣基本上很糟糕
3. 單日變動細微，要抓到變化難上加難
4. 以兩年資料預測一周，時間太長相關性本來就不高
   - 資料時間長對於比特幣這類波動比較大的商品表現很差，可以考慮縮短資料範圍
5. 直接用的結果雖然很差，但預測結果皆落在信賴區間中，還是可以拿有考慮波動的權重作為投資配置的參考
6. 沒把握就跟著無風險資產(定存、債券)走，長期下來基本比自己亂配好

黃金 V.S. 比特幣

謝 謝 大 家

時間序列期末報告
B082040005 高念慈 B082040011 李昀樵

2023/06/06