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LAMPIRAN

Lampiran 1. Data Harga Saham PT Aneka Tambang Tbk (ANTM) Oktober 2020-
Juni 2024

Date	Close Price
Oct,2020	1055
Nov,2020	1145
Dec,2020	1935
Jan,2021	2220
Feb,2021	2840
Mar, 2021	2250
Apr, 2021	2490
May,2021	2450
Jun,2021	2300
Jul,2021	2520
Aug,2021	2390
Sep,2021	2290
Oct,2021	2340
Nov,2021	2300
Dec,2021	2250
Jan,2022	1770
Feb,2022	2220
Mar, 2022	2440
Apr, 2022	2600
May,2022	2510
Jun,2022	1800
Jul,2022	1955
Aug,2022	1990
Sep,2022	1940
Oct,2022	1845
Nov,2022	1985
Dec,2022	1985
Jan,2023	2310
Feb,2023	1990
Mar, 2023	2090
Apr, 2023	2100
May,2023	1895
Jun,2023	1950
Jul,2023	1985
Aug,2023	1990

Lampiran 1. Data Harga Saham PT Aneka Tambang Tbk (ANTM) Oktober 2020-
Juni 2024 (Lanjutan)

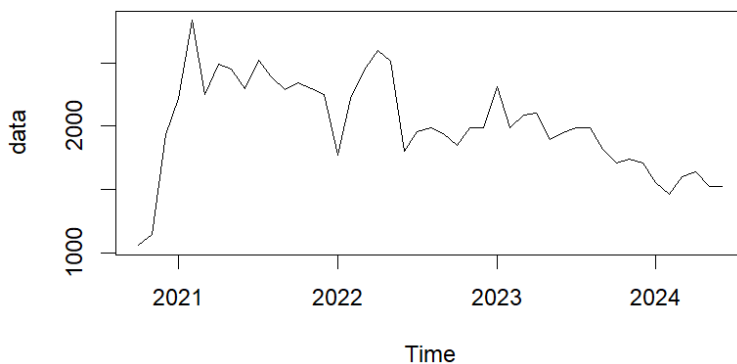
Date	Close Price
Sep,2023	1815
Oct,2023	1705
Nov,2023	1740
Dec,2023	1705
Jan,2024	1550
Feb,2024	1460
Mar,2024	1600
Apr,2024	1640
May,2024	1525
Jun,2024	1250

Lampiran 2. Identifikasi Data

```
> #Loading Packages
> library(tseries)
> library(timeSeries)
> library(timeDate)
> library(forecast)
> library(stats)
> library(strucchange)
> library(changepoint)
> library(ggplot2)
> library(MSWM)

> dt<-read.csv("E:/SKRIPSI METODE MSAR/DATA/ANTM.JK.csv",header=TRUE)
> # Menghitung nilai mean
> mean_value <- mean(dt$Close, na.rm=TRUE)
> mean_value
[1] 2008.667
> # Menghitung nilai median
> median_value <- median(dt$Close, na.rm=TRUE)
> median_value
[1] 1985
> # Standard Deviation
> sd_value <- sd(dt$Close, na.rm=TRUE)
> sd_value
[1] 380.5758
> # Minimum
> min_value <- min(dt$Close, na.rm=TRUE)
> min_value
[1] 1055
> # Maximum
> max_value <- max(dt$Close, na.rm=TRUE)
> max_value
[1] 2840

> data=ts(dt, frequency=12, start=c(2020,10))
> ts.plot(data)
```



Lampiran 3. Identifikasi Perubahan Struktur

```

> ##Loading Package
> library(strucchange)
> library(changepoint)
> ## Uji Perubahan Struktur ##
> Fs.dm=Fstats(data ~ 1)
> sctest(Fs.dm)

      supF test

data:  Fs.dm
sup.F = 17.963, p-value = 0.0006414

> ## Identifikasi Break ##
> bp.dm=breakpoints(data ~ 1)
> summary(bp.dm)

      Optimal (m+1)-segment partition:

Call:
breakpoints.formula(formula = data ~ 1)

Breakpoints at observation number:

m = 1          35
m = 2    6    20
m = 3    6    20    36
m = 4    6 12 20    36
m = 5    6 12 20 26 35
m = 6    6 12 20 27 33 39

Corresponding to breakdates:

m = 1                                2023(8)
m = 2    2021(3)                    2022(5)
m = 3    2021(3)                    2022(5)    2023(9)
m = 4    2021(3) 2021(9) 2022(5)    2023(9)
m = 5    2021(3) 2021(9) 2022(5) 2022(11) 2023(8)
m = 6    2021(3) 2021(9) 2022(5) 2022(12) 2023(6) 2023(12)

Fit:

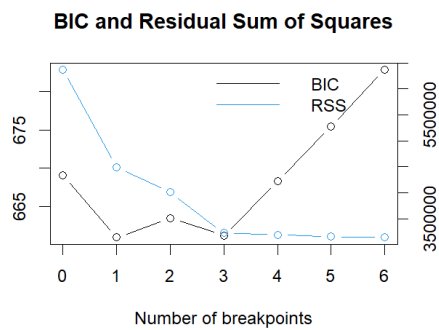
m   0          1          2          3          4
RSS 6372870.0 4495066.8 4014623.2 3221781.4 3185466.5
BIC   669.1    661.0    663.5    661.2    668.3

m   5          6
RSS 3150637.2 3137848.2
BIC   675.4    682.9

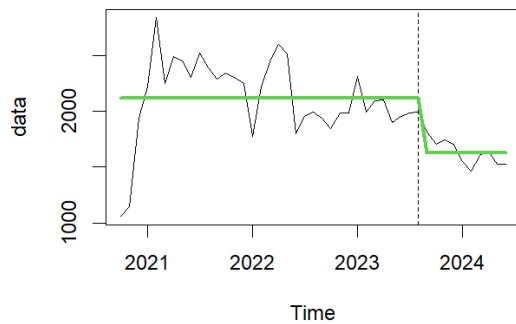
```

Lampiran 3. Identifikasi Perubahan Struktur (Lanjutan)

```
> plot(bp.dm)
```



```
> ts.plot(data)  
> lines(breakpoints(Fs.dm))  
> lines(fitted(bp.dm)~1, col=3, lwd=3)
```



Lampiran 4. Pemodelan MSAR

```

> library(MSWM)
> attach(dt)
> mod=lm(Close ~ 1)
> summary(mod)

Call:
lm(formula = Close ~ 1)

Residuals:
    Min       1Q   Median       3Q      Max
-953.67 -238.67  -23.67   291.33   831.33

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  2008.67     56.73   35.41  <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 380.6 on 44 degrees of freedom

```

```

> ##Model MS(2)-AR(1)##
> ms1=msmFit(mod,k=2,sw=c(TRUE,FALSE,TRUE),p=1)
> summary(ms1)
Markov Switching Model

Call: msmFit(object = mod, k = 2, sw = c(TRUE, FALSE, TRUE),
p = 1)

      AIC      BIC    logLik
604.6242 621.3294 -299.3121

Coefficients:

Regime 1
-----
            Estimate Std. Error t value Pr(>|t|)
(Intercept)(S)  724.9400   165.1900   4.3885 1.141e-05 ***
Close_1         0.5395     0.0992   5.4385 5.373e-08 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 71.97433
Multiple R-squared: 0.539

Standardized Residuals:
    Min       Q1       Med       Q3      Max
-1.010256e+02  4.084399e-06  7.971474e-02  9.830681e-01  9.4
25474e+01

```

Lampiran 4. Pemodelan MSAR (lanjutan)

```

Regime 2
-----
              Estimate Std. Error t value Pr(>|t|)
(Intercept)(S) 1002.4377   214.4793  4.6738 2.957e-06 ***
Close_1         0.5395     0.0992  5.4385 5.373e-08 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' '
1

Residual standard error: 241.4491
Multiple R-squared: 0.3901

Standardized Residuals:
      Min       Q1       Med       Q3      Max
-556.52000 -76.14790 -18.57175 102.69028 639.92731

Transition probabilities:
              Regime 1   Regime 2
Regime 1 0.8976375 0.000680449
Regime 2 0.1023625 0.999319551

> ##Model MS(2)-AR(2)##
> ms2=msmFit(mod,k=2,sw=c(TRUE,FALSE,FALSE,TRUE),p=2)
> summary(ms2)
Markov Switching Model

Call: msmFit(object = mod, k = 2, sw = c(TRUE, FALSE, FALSE,
TRUE),
  p = 2)

      AIC      BIC    logLik
591.4442 613.5338 -291.7221

Coefficients:

Regime 1
-----
              Estimate Std. Error t value Pr(>|t|)
(Intercept)(S) 1348.0530   239.3115  5.6330 1.771e-08 ***
Close_1         0.4426     0.1436  3.0822 0.002055 **
Close_2        -0.0585     0.1206 -0.4851 0.627605
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' '
1

Residual standard error: 227.748
Multiple R-squared: 0.2327

Standardized Residuals:
      Min       Q1       Med       Q3      Max
-506.75327 -116.58322  -7.90024 100.42426 622.64614

```

Lampiran 4. Pemodelan MSAR (lanjutan)

```

Regime 2
-----
              Estimate Std. Error t value Pr(>|t|)
(Intercept)(S) 985.2937   185.8491  5.3016 1.148e-07 ***
Close_1         0.4426    0.1436  3.0822 0.002055 **
Close_2        -0.0585    0.1206 -0.4851 0.627605
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 74.1539
Multiple R-squared: 0.3569

Standardized Residuals:
Min          Q1          Med          Q3          Max
-1.115303e+02  3.516354e-06  6.201164e-03  8.326880e-01  1.0
54571e+02

Transition probabilities:
              Regime 1  Regime 2
Regime 1 0.9996696979 0.1028905
Regime 2 0.0003303021 0.8971095

> ##Model MS(2)-AR(3)##
> ms3=msmFit(mod,k=2,sw=c(TRUE,FALSE,FALSE,FALSE,TRUE),p=3)
> summary(ms3)
Markov Switching Model

Call: msmFit(object = mod, k = 2, sw = c(TRUE, FALSE, FALSE,
FALSE,
TRUE), p = 3)

          AIC          BIC      logLik
580.0267 607.4034 -285.0134

Coefficients:

Regime 1
-----
              Estimate Std. Error t value Pr(>|t|)
(Intercept)(S) 966.6476   241.2655  4.0066 6.16e-05 ***
Close_1         0.4756    0.1546  3.0763 0.002096 **
Close_2         0.1148    0.1713  0.6702 0.502730
Close_3        -0.1898    0.1461 -1.2991 0.193910
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 89.10121
Multiple R-squared: 0.3547

Standardized Residuals:
Min          Q1          Med          Q3          Max
-1.279553e+02  4.891769e-04  1.450665e-01  1.696400e+00  1.2
99686e+02

```

Lampiran 4. Pemodelan MSAR (lanjutan)

```

Regime 2
-----
              Estimate Std. Error t value Pr(>|t|)
(Intercept)(S) 1302.0972   310.3932  4.1950 2.729e-05 ***
Close_1         0.4756     0.1546  3.0763 0.002096 **
Close_2         0.1148     0.1713  0.6702 0.502730
Close_3        -0.1898     0.1461 -1.2991 0.193910
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 221.1925
Multiple R-squared: 0.2734

Standardized Residuals:
      Min       Q1       Med       Q3       Max
-531.00434 -91.44758 -11.35381  86.85906  477.35749

Transition probabilities:
              Regime 1   Regime 2
Regime 1 0.8977271 0.0004781831
Regime 2 0.1022729 0.9995218169

> ##Model MS(2)-AR(4)##
> ms4=msmFit(mod,k=2,sw=c(TRUE,FALSE,FALSE,FALSE,FALSE,TRUE)
,p=4)
> summary(ms4)
Markov Switching Model

Call:  msmFit(object = mod, k = 2, sw = c(TRUE, FALSE, FALSE,
FALSE,
FALSE, TRUE), p = 4)

      AIC      BIC    logLik
568.6848 601.2477 -278.3424

Coefficients:

Regime 1
-----
              Estimate Std. Error t value Pr(>|t|)
(Intercept)(S) 1247.1260   361.1633  3.4531 0.0005542 ***
Close_1         0.4633     0.1607  2.8830 0.0039391 **
Close_2         0.1418     0.1814  0.7817 0.4343909
Close_3        -0.1667     0.1789 -0.9318 0.3514399
Close_4        -0.0138     0.1329 -0.1038 0.9173281
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 224.3304
Multiple R-squared: 0.2758

Standardized Residuals:
      Min       Q1       Med       Q3       Max
-541.15121 -92.43253 -16.81787  92.12714  495.45484

```

Lampiran 4. Pemodelan MSAR (lanjutan)

```

Regime 2
-----
              Estimate Std. Error t value Pr(>|t|)
(Intercept)(S) 925.0591   282.3979   3.2757 0.001054 **
Close_1         0.4633    0.1607   2.8830 0.003939 **
Close_2         0.1418    0.1814   0.7817 0.434391
Close_3        -0.1667    0.1789  -0.9318 0.351440
Close_4        -0.0138    0.1329  -0.1038 0.917328
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' '
1

Residual standard error: 88.02684
Multiple R-squared: 0.3746

Standardized Residuals:
              Min          Q1          Med          Q3
-1.216982e+02  4.159736e-04  1.972540e-01  1.872674e+00
              Max
 1.249676e+02

Transition probabilities:
              Regime 1 Regime 2
Regime 1 0.9994305813 0.1023864
Regime 2 0.0005694187 0.8976136

> ##Model MS(2)-AR(5)##
> ms5=msmFit(mod,k=2,sw=c(TRUE,FALSE,FALSE,FALSE,FALSE,FALSE
,TRUE),p=5)
> summary(ms5)
Markov Switching Model

Call: msmFit(object = mod, k = 2, sw = c(TRUE, FALSE, FALSE,
FALSE,
FALSE, FALSE, FALSE, TRUE), p = 5)

              AIC          BIC      logLik
542.6598 580.3041 -264.3299

Coefficients:

Regime 1
-----
              Estimate Std. Error t value Pr(>|t|)
(Intercept)(S) 425.1877   175.1428   2.4277 0.0151949 *
Close_1         0.4522    0.1217   3.7157 0.0002026 ***
Close_2         0.1202    0.1679   0.7159 0.4740531
Close_3         0.0294    0.1549   0.1898 0.8494659
Close_4         0.0346    0.1459   0.2371 0.8125792
Close_5         0.0778    0.1049   0.7417 0.4582691
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' '
1

Residual standard error: 83.91736
Multiple R-squared: 0.6688

```

Lampiran 4. Pemodelan MSAR (lanjutan)

```

Standardized Residuals:
      Min          Q1          Med          Q3          Max
-122.0991032  -0.2405255   0.9686769   6.0380054  103.998
3114

Regime 2
-----
              Estimate Std. Error t value Pr(>|t|)
(Intercept)(S) 602.4595   270.3893   2.2281 0.0258738 *
Close_1         0.4522    0.1217   3.7157 0.0002026 ***
Close_2         0.1202    0.1679   0.7159 0.4740531
Close_3         0.0294    0.1549   0.1898 0.8494659
Close_4         0.0346    0.1459   0.2371 0.8125792
Close_5         0.0778    0.1049   0.7417 0.4582691
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' '
1

Residual standard error: 201.4762
Multiple R-squared: 0.3277

Standardized Residuals:
      Min          Q1          Med          Q3          Max
-536.29427  -61.24992  -22.93129   41.61030  318.46183

Transition probabilities:
              Regime 1   Regime 2
Regime 1 0.91009599 0.001976395
Regime 2 0.08990401 0.998023605

```

Lampiran 5. Diagnostic Checking

```
> ## Menghitung residual masing-masing model ##
> resid1=msmResid(ms1)

> ## Uji residual nonautokorelasi ##
> diag11=Box.test(resid1,type="Ljung-Box")
> diag11

      Box-Ljung test

data:  resid1
X-squared = 0.51274, df = 1, p-value = 0.474

> ## Uji normalitas residual ##
> library(stats)
> diag211=shapiro.test(resid1)
> diag211

      Shapiro-wilk normality test

data:  resid1
W = 0.95807, p-value = 0.1102

> ## Uji Homogenitas varians residual ##
> diag31=Box.test(resid1^2,type="Ljung-Box")
> diag31

      Box-Ljung test

data:  resid1^2
X-squared = 0.1962, df = 1, p-value = 0.6578
```

Lampiran 6. Peramalan dari Model MS(2)-AR(1)

```

> # Data asli
> yt <- data[2:nrow(data)]
> # Data lag
> yt1 <- data[1:(nrow(data)-1)]
> # Hitung nilai regime sesuai dengan rumus
> regime1=c()
> for (i in (1:34)){
+   hasil1=(0.5395*(yt1[i]-724.9))+724.9
+   regime1=c(regime1,hasil1)
+ }
> regime2=c()
> for (j in (35:44)){
+   hasil2=(0.5395*(yt1[j]-1002.4))+1002.4
+   regime2=c(regime2,hasil2)
+ }
> prediksi=c(regime1,regime2)
> prediksi
[1] 902.9889 951.5439 1377.7489 1531.5064 1865.9965 1547.6
914 1677.1714 1655.5914 1574.6664 1693.3564 1623.2215 1569.2
714
[13] 1596.2464 1574.6664 1547.6914 1288.7314 1531.5064 1650.
1964 1736.5164 1687.9614 1304.9164 1388.5389 1407.4214 1380.
4464
[25] 1329.1939 1404.7240 1404.7240 1580.0614 1407.4214 1461.
3714 1466.7664 1356.1689 1385.8414 1404.7240 1535.2102 1440.
7977
[37] 1381.4527 1400.3352 1381.4527 1297.8302 1249.2752 1324.
8052 1346.3852 1284.3427
> ## Peramalan ##
> Forecast1=0.5395*(data[35]-724.9)+724.9
> Forecast1
[1] 1407.421
> Forecast2=0.5395*(data[45]-1002.4)+1002.4
> Forecast2
[1] 1284.343
> ## MAPE dari Model MS(2)-AR(1) ##
> residu=yt-prediksi
> mape=mean(abs(residu/yt))*100
> mape
[1] 27.2494

```