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LAMPIRAN

Lampiran 1. Data Harga Saham dan *Return* Saham PT. Garuda Indonesia Tbk

No.	Tanggal	Close Price	Return Saham
1	02/01/2023	202.000.000	-0.0076642
2	03/01/2023	188.000.000	-0.0718257
3	04/01/2023	175.000.000	-0.0716559
4	05/01/2023	163.000.000	-0.0710357
5	06/01/2023	152.000.000	-0.0698696
6	09/01/2023	142.000.000	-0.0680534
7	10/01/2023	133.000.000	-0.0654779
8	11/01/2023	124.000.000	-0.0700675
9	12/01/2023	116.000.000	-0.0666913
10	13/01/2023	108.000.000	-0.0714589
11	16/01/2023	101.000.000	-0.0670107
12	17/01/2023	100.000.000	-0.0099503
13	18/01/2023	106.000.000	0.05826890
14	19/01/2023	106.000.000	0
15	20/01/2023	102.000.000	-0.0384662
16	24/01/2023	105.000.000	0.02898753
17	25/01/2023	106.000.000	0.00947874
18	26/01/2023	105.000.000	-0.0094787
19	27/01/2023	98.000.000	-0.0689928
20	30/01/2023	98.000.000	0
21	31/01/2023	99.000.000	0.01015237
22	01/02/2023	99.000.000	0
23	02/02/2023	98.000.000	-0.0101523
24	03/02/2023	99.000.000	0.01015237
25	06/02/2023	100.000.000	0.01005033
26	07/02/2023	98.000.000	-0.0202027
27	08/02/2023	99.000.000	0.01015237
28	09/02/2023	97.000.000	-0.0204088
29	10/02/2023	98.000.000	0.01025650
30	13/02/2023	96.000.000	-0.0206192
31	14/02/2023	97.000.000	0.01036278
32	15/02/2023	98.000.000	0.01025650
33	16/02/2023	97.000.000	-0.0102565
34	17/02/2023	99.000.000	0.02040887
35	20/02/2023	100.000.000	0.01005033
36	21/02/2023	98.000.000	-0.0202027
37	22/02/2023	98.000.000	0
38	23/02/2023	97.000.000	-0.0102565
39	24/02/2023	96.000.000	-0.0103627
40	27/02/2023	202.000.000	-0.0210534
41	28/02/2023	94.000.000	-0.0659579
42	01/03/2023	88.000.000	-0.0584962
43	02/03/2023	83.000.000	0.01197619
44	03/03/2023	84.000.000	0.05781957
45	06/03/2023	89.000.000	0

46	07/03/2023	89.000.000	0
47	08/03/2023	89.000.000	0
48	09/03/2023	89.000.000	-0.0578195
49	10/03/2023	84.000.000	0.02353049
50	13/03/2023	86.000.000	-0.0476280
51	14/03/2023	82.000.000	0
52	15/03/2023	82.000.000	-0.0629138
53	16/03/2023	77.000.000	0.01290340
54	17/03/2023	78.000.000	-0.0259754
55	20/03/2023	76.000.000	0.01307208
56	21/03/2023	77.000.000	0.02564243
57	24/03/2023	79.000.000	0.01257878
58	27/03/2023	80.000.000	0
59	28/03/2023	80.000.000	0.03681397
60	29/03/2023	83.000.000	-0.0621317
61	30/03/2023	78.000.000	-0.0526437
62	31/03/2023	74.000.000	0.03974032
63	03/04/2023	77.000.000	0
64	04/04/2023	77.000.000	-0.0263173
65	05/04/2023	75.000.000	0
66	06/04/2023	75.000.000	-0.0548082
67	10/04/2023	71.000.000	-0.0141846
68	11/04/2023	70.000.000	0.01418463
69	12/04/2023	71.000.000	0
70	13/04/2023	71.000.000	-0.0431721
71	14/04/2023	68.000.000	0
72	17/04/2023	68.000.000	-0.0298529
73	18/04/2023	66.000.000	-0.0307716
74	26/04/2023	64.000.000	0.03077165
75	27/04/2023	66.000.000	0.01503787
76	28/04/2023	67.000.000	-0.0458095
77	02/05/2023	64.000.000	-0.0317486
78	03/05/2023	62.000.000	-0.0162605
79	04/05/2023	61.000.000	0.03226086
80	05/05/2023	63.000.000	0.01574835
81	08/05/2023	64.000.000	0.01550418
82	09/05/2023	65.000.000	-0.0155041
83	10/05/2023	64.000.000	-0.0157483
84	11/05/2023	63.000.000	0
85	12/05/2023	63.000.000	-0.0160003
86	15/05/2023	62.000.000	-0.0666913
87	16/05/2023	58.000.000	-0.0714589
88	17/05/2023	54.000.000	-0.0571584
89	19/05/2023	51.000.000	0.01941808
90	22/05/2023	52.000.000	0.09180754
91	23/05/2023	57.000.000	0.08408311
92	24/05/2023	62.000.000	0.09237332
93	25/05/2023	68.000.000	-0.0451204
94	26/05/2023	65.000.000	-0.0635134
95	29/05/2023	61.000.000	0.09381875

96	30/05/2023	67.000.000	0.02941388
97	31/05/2023	69.000.000	0
98	05/06/2023	69.000.000	-0.0294138
99	06/06/2023	67.000.000	-0.0150378
100	07/06/2023	66.000.000	-0.0152674
101	08/06/2023	65.000.000	0
102	09/06/2023	65.000.000	0.01526747
103	12/06/2023	66.000.000	-0.0152674
104	13/06/2023	65.000.000	0
105	14/06/2023	65.000.000	-0.0312525
106	15/06/2023	63.000.000	0.01574835
107	16/06/2023	64.000.000	0.01550418
108	19/06/2023	65.000.000	-0.0312525
109	20/06/2023	63.000.000	0.01574835
110	21/06/2023	64.000.000	0
111	22/06/2023	64.000.000	-0.0157483
112	23/06/2023	63.000.000	0
113	26/06/2023	63.000.000	0
114	27/06/2023	63.000.000	-0.0160003
115	03/07/2023	62.000.000	0.01600034
116	04/07/2023	63.000.000	0.01574835
117	05/07/2023	64.000.000	0.01550418
118	06/07/2023	65.000.000	-0.0155041
119	07/07/2023	64.000.000	0
120	10/07/2023	64.000.000	0.01550418
121	11/07/2023	65.000.000	0.01526747
122	12/07/2023	66.000.000	0.05884050
123	13/07/2023	70.000.000	-0.0143887
124	14/07/2023	69.000.000	0
125	17/07/2023	69.000.000	-0.0145987
126	18/07/2023	68.000.000	-0.0148150
127	20/07/2023	67.000.000	-0.0150378
128	21/07/2023	66.000.000	-0.0152674
129	24/07/2023	65.000.000	
130	25/07/2023	65.000.000	0.01526747
131	26/07/2023	66.000.000	-0.0152674
132	27/07/2023	65.000.000	-0.0155041
133	28/07/2023	64.000.000	0.01550418
134	31/07/2023	65.000.000	-0.0312525
135	01/08/2023	63.000.000	-0.0160003
136	02/08/2023	62.000.000	0
137	03/08/2023	62.000.000	0
138	04/08/2023	62.000.000	0
139	07/08/2023	62.000.000	0
140	08/08/2023	62.000.000	-0.0162605
141	09/08/2023	61.000.000	0.03226086
142	10/08/2023	63.000.000	0
143	11/08/2023	63.000.000	0.03125254
144	14/08/2023	65.000.000	0
145	15/08/2023	65.000.000	0

146	16/08/2023	65.000.000	-0.0155041
147	18/08/2023	64.000.000	0.04580953
148	21/08/2023	67.000.000	0.08576682
149	22/08/2023	73.000.000	0.09156719
150	23/08/2023	80.000.000	0.09531017
151	24/08/2023	88.000.000	0.08701137
152	25/08/2023	96.000.000	-0.0757118
153	28/08/2023	89.000.000	0.01117330
154	29/08/2023	90.000.000	0
155	30/08/2023	90.000.000	0
156	31/08/2023	90.000.000	-0.1053605
157	01/09/2023	81.000.000	0.01227009
158	04/09/2023	82.000.000	0.09309042
159	05/09/2023	90.000.000	0.03278982
160	06/09/2023	93.000.000	-0.0108109
161	07/09/2023	92.000.000	-0.0109290
162	08/09/2023	91.000.000	-0.0222231
163	11/09/2023	89.000.000	0.05465841
164	12/09/2023	94.000.000	-0.0215062
165	13/09/2023	92.000.000	0.05292240
166	14/09/2023	97.000.000	-0.0208340
167	15/09/2023	95.000.000	-0.0652405
168	18/09/2023	89.000.000	0.02222313
169	19/09/2023	91.000.000	-0.0110498
170	20/09/2023	90.000.000	0
171	21/09/2023	90.000.000	0.02197890
172	22/09/2023	92.000.000	-0.0219789
173	25/09/2023	90.000.000	-0.0111733
174	26/09/2023	89.000.000	-0.0112995
175	27/09/2023	88.000.000	0.04445176
176	29/09/2023	92.000.000	0
177	02/10/2023	92.000.000	0
178	03/10/2023	92.000.000	-0.0219789
179	04/10/2023	90.000.000	0.01104983
180	05/10/2023	91.000.000	0
181	06/10/2023	91.000.000	0.01092907
182	09/10/2023	92.000.000	-0.0109290
183	10/10/2023	91.000.000	-0.0110498
184	11/10/2023	90.000.000	-0.0339015
185	12/10/2023	87.000.000	0
186	13/10/2023	87.000.000	-0.0232568
187	16/10/2023	85.000.000	0.01169603
188	17/10/2023	86.000.000	0
189	18/10/2023	86.000.000	-0.0116960
190	19/10/2023	85.000.000	-0.0359320
191	20/10/2023	82.000.000	-0.0372713
192	23/10/2023	79.000.000	0.08489944
193	24/10/2023	86.000.000	0.01156082
194	25/10/2023	87.000.000	-0.0470675
195	26/10/2023	83.000.000	0.09201889

196	27/10/2023	91.000.000	0
197	30/10/2023	91.000.000	-0.0110498
198	31/10/2023	90.000.000	-0.0454623
199	01/11/2023	86.000.000	0.01156082
200	02/11/2023	87.000.000	0.01142869
201	03/11/2023	88.000.000	0.01129955
202	06/11/2023	89.000.000	-0.0112995
203	07/11/2023	88.000.000	-0.0114286
204	08/11/2023	87.000.000	0.01142869
205	09/11/2023	88.000.000	0
206	10/11/2023	88.000.000	-0.0114286
207	13/11/2023	87.000.000	0.04495138
208	14/11/2023	91.000.000	-0.0110498
209	15/11/2023	90.000.000	-0.0224728
210	16/11/2023	88.000.000	0
211	17/11/2023	88.000.000	0
212	20/11/2023	88.000.000	-0.0114286
213	21/11/2023	87.000.000	-0.0232568
214	22/11/2023	85.000.000	0.01169603
215	23/11/2023	86.000.000	0
216	24/11/2023	86.000.000	-0.0116960
217	27/11/2023	85.000.000	-0.0118344
218	28/11/2023	84.000.000	0
219	29/11/2023	84.000.000	0.01183445
220	30/11/2023	85.000.000	-0.0118344
221	01/12/2023	84.000.000	0.01183445
222	04/12/2023	85.000.000	-0.0238106
223	05/12/2023	83.000.000	0.01197619
224	06/12/2023	84.000.000	0
225	07/12/2023	84.000.000	0.02353049
226	08/12/2023	86.000.000	-0.0355066
227	11/12/2023	83.000.000	-0.0243914
228	12/12/2023	81.000.000	0.01227009
229	13/12/2023	82.000.000	0
230	14/12/2023	82.000.000	-0.0122700
231	15/12/2023	81.000.000	-0.1039897
232	18/12/2023	73.000.000	0.05334598
233	19/12/2023	77.000.000	-0.0130720
234	20/12/2023	76.000.000	-0.0822380
235	21/12/2023	70.000.000	0.01418463
236	22/12/2023	71.000.000	-0.0141846
237	27/12/2023	70.000.000	0
238	28/12/2023	70.000.000	-0.0143887
239	29/12/2023	69.000.000	0

Lampiran 2. Perhitungan *Mean Absolute Percentage Error*

t	Harga Aktual	Harga Prediksi	*Error*	$\left\|\frac{A_t - F_t}{A_t}\right\|$
1	890000000	950000000	-60000000	-0,06316
2	910000000	94445873	815554127	8,635148
3	9000000000	94096378	8905903622	94,64661
4	9000000000	96933084	8903066916	91,84756
5	920000000	95261768	824738232	8,657599
6	9000000000	93324366	8906675634	95,43784
7	890000000	95776112	794223888	8,292505
8	880000000	95341442	784658558	8,229984
9	920000000	94695058	825304942	8,715396
10	920000000	90985594	829014406	9,111491
11	920000000	81556474	838443526	10,28053
12	9000000000	79775719	8920224281	111,8163
13	910000000	77565651	832434349	10,732
14	910000000	78337051	831662949	10,61647
15	920000000	79486605	840513395	10,57428
16	910000000	75806336	834193664	11,00427
17	9000000000	75946722	8924053278	117,5041
18	870000000	73700861	796299139	10,80448
19	870000000	77783648	792216352	10,18487
20	850000000	76974100	773025900	10,04268
21	860000000	81377416	778622584	9,568043
22	860000000	80630172	779369828	9,665982
23	850000000	84399757	765600243	9,071119
24	820000000	84315821	735684179	8,72534
25	790000000	83052013	706947987	8,512111
26	860000000	83063792	776936208	9,353488
27	870000000	88402649	781597351	8,841334
28	830000000	84881889	745118111	8,778293
29	910000000	81638888	828361112	10,14665
30	910000000	87542600	822457400	9,394939
31	9000000000	89410833	8910589167	99,65894
32	860000000	83063817	776936183	9,353485
33	870000000	87652056	782347944	8,925609
34	880000000	90697531	789302469	8,702579
35	890000000	85691566	804308434	9,386086
36	880000000	83275945	796724055	9,567277
37	870000000	87098901	782901099	8,988645
38	880000000	88399559	791600441	8,954801
39	880000000	91078285	788921715	8,662018
40	870000000	88749272	781250728	8,802897
41	910000000	88483870	821516130	9,28436
42	9000000000	89943259	8910056741	99,06309

43	880000000	91072480	788927520	8,662634
44	880000000	89015177	790984823	8,885955
45	880000000	89695789	790304211	8,81094
46	870000000	88792891	781207109	8,798082
47	850000000	90720073	759279927	8,369481
48	860000000	84472101	775527899	9,180876
49	860000000	82418051	777581949	9,434607
50	850000000	83212874	766787126	9,214766
51	840000000	83969646	756030354	9,003615
52	840000000	81997094	758002906	9,244265
53	850000000	85203051	764796949	8,976169
54	840000000	84031912	755968088	8,996202
55	850000000	85783878	764216122	8,908622
56	830000000	85430914	744569086	8,715453
57	840000000	88424113	751575887	8,499671
58	840000000	90232133	749767867	8,309322
59	860000000	87677331	772322669	8,808693
60	830000000	85739180	744260820	8,680522
61	810000000	81166712	728833288	8,979461
62	820000000	83353603	736646397	8,837607
63	820000000	84992919	735007081	8,647863
64	810000000	85229061	724770939	8,503801
65	730000000	79865828	650134172	8,14033
66	770000000	76680577	693319423	9,041656
67	760000000	75893915	684106085	9,013978
68	7000000000	72951707	6927048293	94,95389
69	710000000	71622266	638377734	8,913118
70	7000000000	75941121	6924058879	91,17667
71	7000000000	76987022	6923012978	89,92442
72	690000000	72621816	617378184	8,501277
		Total		
			N	72
			MAPE	**4.827189 %**

Lampiran 3. Sintaks Program *Software* R Model *Geometric Brownian Motion*

```
> library(readxl)
> load("pkg.RData")
> set.seed(8)

> # data_set  <- read.csv('PGAS.JK.csv', sep = ';')
> data_set  <- read_excel('Data PT Garuda Tbk.xlsx')
> data_set  <- data.frame(data_set)
> N         <- dim(data_set)[1]
> data_olah <- data_set

> head(data_olah)
        Date      Open      High       Low     Close
Adj.Close
1 2023-01-02 203554123 203554123 203554123 203554123
203554123
2 2023-01-03 204000000 224000000 190000000 202000000
202000000
3 2023-01-04 194000000 204000000 188000000 188000000
188000000
4 2023-01-05 177000000 183000000 175000000 175000000
175000000
5 2023-01-06 175000000 175000000 163000000 163000000
163000000
6 2023-01-09 152000000 159000000 152000000 152000000
152000000
     Volume
1         0
2 231656400
3 112231400
4  13209400
5   8413200
6 133805400

> n <- dim(data_olah)[1]
> p <- dim(data_olah)[2]

> date        <- data_olah$Date
> giaa.prices <- data_olah$Close

> library("moments")
> ## Statistik Deskriptif Harga Saham##
> data.frame(
+   Variabel = "GIAA",
+   Min = min(giaa.prices),
+   Max = max(giaa.prices),
+   Mean = mean(giaa.prices),
```

```
+   Std.Deviasi = sd(giaa.prices),
+   Kurtosis = kurtosis(giaa.prices),
+   Skewness = skewness(giaa.prices)
+ )
  Variabel     Min       Max     Mean Std.Deviasi Kur
tosis Skewness
1     GIAA 5.1e+07 203554123 83010687    21651292 13.
57051 2.581786

> library("ggplot2")
> ggplot(data.frame(x=c(1:n), y = giaa.prices)) +
+   geom_line(aes(x=x, y=y), color = "#008080") +
+   geom_point(aes(x=x, y=y)) +
+   ylab("Rupiah") + xlab("Periode")

> # Pembagian data in sample dan out sample
> # 70:30 (167 data in sampe & 72 data out sample)
> n1 <- round(70/100 * n,0)
> giaa.insamp  <- giaa.prices [1:n1]
> giaa.outsamp <- giaa.prices [(n1+1):n]

> # Perhitungan nilai return saham data in sample #
> # H0 : Data Berdistribusi normal                #
> # H1 : Data tidak Berdistribusi normal          #
> # Tolak H0 jika p-value < 0.05                  #

> ret.insample <- diff(diff(diff(diff(log(giaa.insamp
))))))
> ks.test(ret.insample,"pnorm", mean = mean(ret.insam
ple), sd = sd(ret.insample), )

        Asymptotic one-sample Kolmogorov-Smirnov test

data:  ret.insample
D = 0.060399, p-value = 0.5918
alternative hypothesis: two-sided

Warning message:
In ks.test.default(ret.insample, "pnorm", mean = mean
(ret.insample),  :
  ties should not be present for the one-sample Kolmo
gorov-Smirnov test

> ## Perhitungan Return Saham ##
> R      <- c();for (i in 1:(n-1)) {R[i] <- log(giaa.
prices[i+1] / giaa.prices[i])}
> E.miu  <- mean(R)                          # Ekspekta
si miu
> E.sig2 <- 1/(n-1) * sum((R - mean(R))^2) # Ekspekta
si Sigma^2
```

```
> E.sig  <- sqrt(E.sig2)                    # Ekspekta
si Volatilitas

> ## PLot Return Saham
> ggplot(data.frame(x=c(1:(n-1)),y = R)) +
+   geom_hline(yintercept = 0, size = 1, color="#FF80
80") +
+   geom_line(aes(x=x, y=y)) +
+   geom_point(aes(x=x, y=y), color="#008080") +
+   ylab("Return (Ri)") + xlab("Hari ke-")

> # Estimasi Parameter Geometric Brownian Motion
> exp.ret  <- mean(ret.insample); exp.ret
[1] -0.001303781
> vars.ret <- var (ret.insample); vars.ret
[1] 0.01606697
> vol.ret  <- sqrt(vars.ret); vol.ret
[1] 0.1267555

> pred.prices <- gbms(giaa.insamp[n1], (length(giaa.o
utsamp)-1), E.miu, E.sig, tau = min.tau)
>
> ket1 <- data.frame(x = c(1:length(pred.prices)), ke
terangan = "actual")
> ket2 <- data.frame(x = c(1:length(pred.prices)), ke
terangan = "predict")
> ket. <- rbind(ket1,ket2)
> df1  <- data.frame(y = c(giaa.outsamp, pred.prices)
, ket = ket.)
>
> colnames(df1) <- c("y","x", "keterangan")
>
> ggplot(df1) +
+   geom_line(aes(x = x, y = y, color = keterangan))
+
+   geom_point(aes(x = x, y = y, color = keterangan))
+
+   ylab("Rupiah") + xlab("Periode")

> ## Save Data Perbandingan Actual dengan Prediksi ##
> aktual_vs_prediksi <- data.frame(
+          t = c(1:length((n1+1):n)),
+   tanggal  = data_olah$Date[(n1+1):n],
+   aktual   = giaa.outsamp,
+   prediksi = round(pred.prices,0)
+ )

> write.table(aktual_vs_prediksi, "Output/Aktual vs P
rediksi.csv", row.names = F, sep = ";")
```

Lampiran 4. Sintaks Program *Software* R *Mean Absolute Precentage Error* (MAPE)

```
> min.tau  <- 0
> min.mape <- 100
> for (i in 1:length(giaa.outsamp)) {
+   cat("\ntau:",i,"\t-> ")
+   pred.prices <- gbms(giaa.insamp[n1], (length(giaa
.outsamp)-1), E.miu, E.sig, tau = i)
+   mape <- MAPE(giaa.outsamp,pred.prices)
+   if(mape < min.mape){min.mape <- mape;min.tau<-i}
+ };message("\n\nmin MAPE: ", min.mape);message("min
tau : ",min.tau)

tau: 1       -> tingkat kesalahan peramalan = 10.05374
%
tau: 2       -> tingkat kesalahan peramalan = 9.540276
%
tau: 3       -> tingkat kesalahan peramalan = 9.177093
%
tau: 4       -> tingkat kesalahan peramalan = 8.910772
%
tau: 5       -> tingkat kesalahan peramalan = 8.692687
%
tau: 6       -> tingkat kesalahan peramalan = 8.493156
%
tau: 7       -> tingkat kesalahan peramalan = 8.321334
%
tau: 8       -> tingkat kesalahan peramalan = 8.1648 %
tau: 9       -> tingkat kesalahan peramalan = 8.021838
%
tau: 10      -> tingkat kesalahan peramalan = 7.892868
%
tau: 11      -> tingkat kesalahan peramalan = 7.768896
%
tau: 12      -> tingkat kesalahan peramalan = 7.649264
%
tau: 13      -> tingkat kesalahan peramalan = 7.533447
%
tau: 14      -> tingkat kesalahan peramalan = 7.421017
%
tau: 15      -> tingkat kesalahan peramalan = 7.319086
%
tau: 16      -> tingkat kesalahan peramalan = 7.220491
%
tau: 17      -> tingkat kesalahan peramalan = 7.124134
%
tau: 18      -> tingkat kesalahan peramalan = 7.029826
%
```

```
tau: 19      -> tingkat kesalahan peramalan = 6.937401
%
tau: 20      -> tingkat kesalahan peramalan = 6.846717
%
tau: 21      -> tingkat kesalahan peramalan = 6.76114
%
tau: 22      -> tingkat kesalahan peramalan = 6.680866
%
tau: 23      -> tingkat kesalahan peramalan = 6.602815
%
tau: 24      -> tingkat kesalahan peramalan = 6.527633
%
tau: 25      -> tingkat kesalahan peramalan = 6.453496
%
tau: 26      -> tingkat kesalahan peramalan = 6.380346
%
tau: 27      -> tingkat kesalahan peramalan = 6.308984
%
tau: 28      -> tingkat kesalahan peramalan = 6.244807
%
tau: 29      -> tingkat kesalahan peramalan = 6.183379
%
tau: 30      -> tingkat kesalahan peramalan = 6.122603
%
tau: 31      -> tingkat kesalahan peramalan = 6.063848
%
tau: 32      -> tingkat kesalahan peramalan = 6.008793
%
tau: 33      -> tingkat kesalahan peramalan = 5.959119
%
tau: 34      -> tingkat kesalahan peramalan = 5.910212
%
tau: 35      -> tingkat kesalahan peramalan = 5.861712
%
tau: 36      -> tingkat kesalahan peramalan = 5.813602
%
tau: 37      -> tingkat kesalahan peramalan = 5.765867
%
tau: 38      -> tingkat kesalahan peramalan = 5.718494
%
tau: 39      -> tingkat kesalahan peramalan = 5.671532
%
tau: 40      -> tingkat kesalahan peramalan = 5.628858
%
tau: 41      -> tingkat kesalahan peramalan = 5.587511
%
tau: 42      -> tingkat kesalahan peramalan = 5.550207
%
tau: 43      -> tingkat kesalahan peramalan = 5.516397
%
```

```
tau: 44      -> tingkat kesalahan peramalan = 5.482764
%
tau: 45      -> tingkat kesalahan peramalan = 5.449302
%
tau: 46      -> tingkat kesalahan peramalan = 5.416005
%
tau: 47      -> tingkat kesalahan peramalan = 5.382871
%
tau: 48      -> tingkat kesalahan peramalan = 5.349893
%
tau: 49      -> tingkat kesalahan peramalan = 5.317069
%
tau: 50      -> tingkat kesalahan peramalan = 5.284394
%
tau: 51      -> tingkat kesalahan peramalan = 5.251865
%
tau: 52      -> tingkat kesalahan peramalan = 5.219477
%
tau: 53      -> tingkat kesalahan peramalan = 5.187228
%
tau: 54      -> tingkat kesalahan peramalan = 5.159036
%
tau: 55      -> tingkat kesalahan peramalan = 5.134838
%
tau: 56      -> tingkat kesalahan peramalan = 5.113016
%
tau: 57      -> tingkat kesalahan peramalan = 5.091252
%
tau: 58      -> tingkat kesalahan peramalan = 5.069546
%
tau: 59      -> tingkat kesalahan peramalan = 5.047897
%
tau: 60      -> tingkat kesalahan peramalan = 5.026506
%
tau: 61      -> tingkat kesalahan peramalan = 5.006502
%
tau: 62      -> tingkat kesalahan peramalan = 4.986545
%
tau: 63      -> tingkat kesalahan peramalan = 4.966634
%
tau: 64      -> tingkat kesalahan peramalan = 4.946769
%
tau: 65      -> tingkat kesalahan peramalan = 4.928905
%
tau: 66      -> tingkat kesalahan peramalan = 4.911703
%
tau: 67      -> tingkat kesalahan peramalan = 4.894526
%
tau: 68      -> tingkat kesalahan peramalan = 4.877376
%
```

```
tau: 69      -> tingkat kesalahan peramalan = 4.860252
%
tau: 70      -> tingkat kesalahan peramalan = 4.844905
%
tau: 71      -> tingkat kesalahan peramalan = 4.832988
%
tau: 72      -> tingkat kesalahan peramalan = 4.827189
%

min MAPE: 4.82718913257359
min tau : 72
> mape <- MAPE(giaa.outsamp, pred.prices)
tingkat kesalahan peramalan = 4.827189 %
```

Lampiran 5. Sintaks Program *Software* R *Value at Risk*

```
> # Value at Risk #
> giaa.jan   <- gbms(giaa.outsamp[length((n1+1):n)],
30, E.miu, E.sig, tau = min.tau)
> prices.jan <- giaa.jan
> return.jan <- giaa.jan
> x          <- diff(log(return.jan))
>
> ## Tabel Hasil Pereamalan ##
> write.table(data.frame(hari = c(1:31), Close = roun
d(giaa.jan,0)), "Output/hasil Prediksi.csv", row.name
s = F, sep = ";")
>
> # Perhitungan nilai return saham data in sample #
> # H0 : Data Berdistribusi normal                  #
> # H1 : Data tidak Berdistribusi normal            #
> # Tolak H0 jika p-value < 0.05                    #
>
> #Uji Normalitas return saham
> ks.test(x,"pnorm", mean = mean(x), sd=sd(x))

        Exact one-sample Kolmogorov-Smirnov test

data:  x
D = 0.12632, p-value = 0.6782
alternative hypothesis: two-sided

>
> ## Pembentukan Jendela Uji ##
> return.saham    <- c()
> return.saham[1] <- 0;for (i in 2:n) {return.saham[i
] <- (giaa.prices[i] - giaa.prices[i-1]) / giaa.price
s[i-1]}
> k1 <- return.saham[1:17];miu.k1<-mean(k1);sd.k1<-sd
(k1) #jendela uji 1 (k=18)
> k2 <- return.saham[2:18];miu.k2<-mean(k2);sd.k2<-sd
(k2) #jendela uji 2 (k=19)
> k3 <- return.saham[3:19];miu.k3<-mean(k3);sd.k3<-sd
(k3) #jendela uji 3 (k=20)
> k4 <- return.saham[4:20];miu.k4<-mean(k4);sd.k4<-sd
(k4) #jendela uji 4 (k=21)
> k5 <- return.saham[5:21];miu.k5<-mean(k5);sd.k5<-sd
(k5) #jendela uji 5 (k=22)
>
> ## Tabel Nilai Rata-rata dan Standar deviasi Return
saham window ##
> data.frame(
+   Window_ke = c(1:5),
+   k = c('1-17', '2-18', '3-19', '4-20', '5-21'),
```

```
+   Expected_Return = c(miu.k1, miu.k2, miu.k3, miu.k
4, miu.k5),
+   Std.Deviasi_Return = c(sd.k1, sd.k2, sd.k3, sd.k4
, sd.k5)
+ )
  Window_ke    k Expected_Return Std.Deviasi_Return
1         1 1-17     -0.03738279         0.04121100
2         2 2-18     -0.03682256         0.04181131
3         3 3-19     -0.03692839         0.04173502
4         4 4-20     -0.03677308         0.04161173
5         5 5-21     -0.03270549         0.04162884
>
>
> VaR18 <- VaR(17, miu.k1, sd.k1, 1, 1, 78800, 0.05)
Nilai Value at Risk = -0.09563906
> VaR19 <- VaR(17, miu.k2, sd.k2, 1, 1, 78800, 0.05)
Nilai Value at Risk = -0.09601692
> VaR20 <- VaR(17, miu.k3, sd.k3, 1, 1, 78800, 0.05)
Nilai Value at Risk = -0.0959466
> VaR21 <- VaR(17, miu.k4, sd.k4, 1, 1, 78800, 0.05)
Nilai Value at Risk = -0.09553903
> VaR22 <- VaR(17, miu.k5, sd.k5, 1, 1, 78800, 0.05)
Nilai Value at Risk = -0.09164087
```

Lampiran 6. Sintaks Program *Software* R uji *backtesting* estimasi *Value at Risk*

```
> ## Function Backtesting Estimasi Value at Risk ##
> ret <- c(sd.k1, sd.k2, sd.k3, sd.k4, sd.k5)
> Var <- c(VaR18, VaR19, VaR20, VaR21, VaR22)
>
> backtesting(ret, Var, 0.01)
Nilai Rasio Pelanggaran = 0
> backtesting(ret, Var, 0.02)
Nilai Rasio Pelanggaran = 0
> backtesting(ret, Var, 0.03)
Nilai Rasio Pelanggaran = 0
> backtesting(ret, Var, 0.04)
Nilai Rasio Pelanggaran = 0
> backtesting(ret, Var, 0.05)
Nilai Rasio Pelanggaran = 0
```