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LAMPIRAN

Lampiran 1. Data Harga Saham PT. Bank Central Asia Tbk.

Waktu	Harga Close (Rupiah)
2019-01-02	5240
2019-01-03	5180
2019-01-04	5205
2019-01-07	5245
2019-01-08	5240
2019-01-09	5255
2019-01-10	5255
2019-01-11	5250
2019-01-14	5200
2019-01-15	5260
2019-01-16	5285
2019-01-17	5330
2019-01-18	5425
2019-01-21	5545
2019-01-22	5600
2019-01-23	5500
2019-01-24	5460
2019-01-25	5500
2019-01-28	5495
2019-01-29	5540
2019-01-30	5520
2019-01-31	5635
2019-02-01	5635
2019-02-04	5500
2019-02-05	5500
2019-07-18	6145
2019-07-19	6200
2019-07-22	6290
2019-07-23	6235
2019-07-24	6250
2019-07-25	6250
2019-07-26	6195
2019-07-29	6190
2019-07-30	6220
2019-07-31	6190
⋮	⋮
⋮	⋮
⋮	⋮
2020-03-5	6435
2020-03-6	6200
2020-03-9	5785
2020-03-10	5925
2020-03-11	5850
2020-03-12	5560

Lampiran 2. Uji *Augmented Dickey-Fuller*

a. Sebelum *differencing*

Null Hypothesis: BCA has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=15)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.998585	0.7542
Test critical values:	1% level	-3.456302	
	5% level	-2.872857	
	10% level	-2.572875	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(BCA)
Method: Least Squares
Date: 06/21/22 Time: 02:52
Sample (adjusted): 1/03/2019 12/19/2019
Included observations: 251 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
BCA(-1)	-0.010402	0.010417	-0.998585	0.3190
C	66.26877	61.03942	1.085672	0.2787

R-squared	0.003989	Mean dependent var	5.418327
Adjusted R-squared	-0.000011	S.D. dependent var	56.08676
S.E. of regression	56.08707	Akaike info criterion	10.89962
Sum squared resid	783294.2	Schwarz criterion	10.92772
Log likelihood	-1365.903	Hannan-Quinn criter.	10.91093
F-statistic	0.997172	Durbin-Watson stat	2.082396
Prob(F-statistic)	0.318965		

b. Setelah *differencing*

Null Hypothesis: D(BCA) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=15)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-16.64248	0.0000
Test critical values:	1% level	-3.456408	
	5% level	-2.872904	
	10% level	-2.572900	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(BCA,2)
Method: Least Squares
Date: 06/21/22 Time: 02:53
Sample (adjusted): 1/04/2019 12/19/2019
Included observations: 250 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(BCA(-1))	-1.069163	0.064243	-16.64248	0.0000
C	6.099130	3.564821	1.710921	0.0883

R-squared	0.527594	Mean dependent var	-0.380000
Adjusted R-squared	0.525689	S.D. dependent var	81.35250
S.E. of regression	56.02764	Akaike info criterion	10.89754
Sum squared resid	778496.1	Schwarz criterion	10.92571
Log likelihood	-1360.192	Hannan-Quinn criter.	10.90887
F-statistic	276.9723	Durbin-Watson stat	1.980265
Prob(F-statistic)	0.000000		

Lampiran 3. Pendugaan Model Tentatif ARIMA

a. Pendugaan Model ARIMA (0,1,1)

Dependent Variable: D(CLOSE)
Method: ARMA Maximum Likelihood (OPG - BHHH)
Date: 06/07/22 Time: 22:49
Sample: 1/03/2019 12/19/2019
Included observations: 251
Convergence achieved after 33 iterations
Coefficient covariance computed using outer product of gradients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.483372	3.297665	1.662804	0.0976
MA(1)	-0.080316	0.039808	-2.017592	0.0447
SIGMASQ	3116.262	189.1873	16.47184	0.0000

R-squared	0.005403	Mean dependent var	5.418327
Adjusted R-squared	-0.002618	S.D. dependent var	56.08676
S.E. of regression	56.16012	Akaike info criterion	10.90620
Sum squared resid	782181.8	Schwarz criterion	10.94833
Log likelihood	-1365.728	Hannan-Quinn criter.	10.92315
F-statistic	0.673645	Durbin-Watson stat	1.958561
Prob(F-statistic)	0.510777		

Inverted MA Roots	.08

b. Uji Diagnostik Model ARIMA

1) Uji Ljung-Box Model ARIMA

Date: 06/14/22 Time: 00:46
Sample: 1/02/2019 12/19/2019
Included observations: 251

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.321	0.321	26.200	0.000
		2	0.183	0.089	34.767	0.000
		3	0.023	-0.067	34.899	0.000
		4	-0.008	-0.015	34.918	0.000
		5	-0.001	0.018	34.918	0.000
		6	-0.037	-0.042	35.281	0.000
		7	-0.029	-0.011	35.498	0.000
		8	-0.015	0.008	35.560	0.000
		9	-0.050	-0.050	36.225	0.000
		10	0.017	0.048	36.300	0.000
		11	-0.008	-0.014	36.318	0.000
		12	0.087	0.091	38.329	0.000
		13	-0.030	-0.091	38.575	0.000
		14	-0.042	-0.036	39.038	0.000
		15	-0.025	0.018	39.205	0.001
		16	-0.081	-0.075	40.999	0.001
		17	-0.047	-0.010	41.605	0.001
		18	0.013	0.062	41.651	0.001
		19	0.033	0.022	41.949	0.002
		20	0.064	0.027	43.064	0.002
		21	0.014	-0.010	43.120	0.003
		22	-0.017	-0.050	43.204	0.004
		23	-0.055	-0.042	44.050	0.005
		24	-0.089	-0.068	46.262	0.004
		25	-0.049	0.015	46.933	0.005
		26	-0.054	-0.017	47.754	0.006
		27	-0.052	-0.039	48.523	0.007
		28	-0.037	0.010	48.907	0.009
		29	-0.044	-0.028	49.464	0.010
		30	-0.032	-0.041	49.758	0.013
		31	-0.027	-0.010	49.975	0.017
		32	-0.037	-0.039	50.382	0.020
		33	-0.052	-0.044	51.179	0.023
		34	-0.044	0.004	51.743	0.026
		35	-0.012	0.019	51.787	0.034
		36	-0.010	0.002	51.819	0.043

2) Uji *Lag*range Multiplier Model ARIMA

Heteroskedasticity Test: ARCH

F-statistic	29.29574	Prob. F(1,248)	0.0000
Obs*R-squared	26.41200	Prob. Chi-Square(1)	0.0000

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 06/14/22 Time: 00:55
Sample (adjusted): 1/04/2019 12/19/2019
Included observations: 250 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2108.199	445.5781	4.731380	0.0000
RESID^2(-1)	0.328925	0.060771	5.412554	0.0000

R-squared	0.105648	Mean dependent var	3111.685
Adjusted R-squared	0.102042	S.D. dependent var	6760.590
S.E. of regression	6406.380	Akaike info criterion	20.37594
Sum squared resid	1.02E+10	Schwarz criterion	20.40412
Log likelihood	-2544.993	Hannan-Quinn criter.	20.38728
F-statistic	29.29574	Durbin-Watson stat	2.075521
Prob(F-statistic)	0.000000		

Lampiran 4. Pendugaan Model GARCH Sementara

Model ARIMA (0,1,1) GARCH(1,1)

Dependent Variable: D(BCA)
Method: ML - ARCH
Date: 06/14/22 Time: 01:10
Sample (adjusted): 1/03/2019 12/19/2019
Included observations: 251 after adjustments
Convergence achieved after 24 iterations
Coefficient covariance computed using outer product of gradients
MA Backcast: 1/02/2019
Presample variance: backcast (parameter = 0.7)
GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	4.900272	2.623250	1.868016	0.0618
MA(1)	-0.200545	0.081691	-2.454934	0.0141
Variance Equation				
C	1264.707	338.7337	3.733632	0.0002
RESID(-1)^2	0.310804	0.079348	3.916978	0.0001
GARCH(-1)	0.291411	0.140043	2.080878	0.0374

R-squared	-0.007031	Mean dependent var	5.418327
Adjusted R-squared	-0.011075	S.D. dependent var	56.08676
S.E. of regression	56.39648	Akaike info criterion	10.78379
Sum squared resid	791960.1	Schwarz criterion	10.85402
Log likelihood	-1348.366	Hannan-Quinn criter.	10.81205
Durbin-Watson stat	1.747223		

Inverted MA Roots	.20

Lampiran 5. Pendugaan Model E-GARCH

a. Model ARIMA(0,1,1) E-GARCH(1,1)

Dependent Variable: D(BCA)
Method: ML - ARCH
Date: 06/23/22 Time: 03:46
Sample (adjusted): 1/03/2019 12/19/2019
Included observations: 251 after adjustments
Convergence achieved after 22 iterations
MA Backcast: 1/02/2019
Presample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(3) + C(4)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(5)*RESID(-1)/@SQRT(GARCH(-1)) + C(6)*LOG(GARCH(-1))

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	5.233375	2.500240	2.093149	0.0363
MA(1)	-0.220681	0.078210	-2.821665	0.0048
Variance Equation				
C(3)	3.559491	1.015289	3.505888	0.0005
C(4)	0.578184	0.095314	6.066090	0.0000
C(5)	0.000740	0.069389	0.010669	0.9915
C(6)	0.497157	0.130451	3.811061	0.0001

R-squared	-0.011483	Mean dependent var	5.418327
Adjusted R-squared	-0.015546	S.D. dependent var	56.08676
S.E. of regression	56.52103	Akaike info criterion	10.79412
Sum squared resid	795462.1	Schwarz criterion	10.87840
Log likelihood	-1348.662	Hannan-Quinn criter.	10.82804
Durbin-Watson stat	1.711413		

Inverted MA Roots	.22

b. Model ARIMA(0,1,1) E-GARCH(1,2)

Dependent Variable: D(BCA)
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)
Date: 06/23/22 Time: 01:38
Sample (adjusted): 1/03/2019 12/19/2019
Included observations: 251 after adjustments
Convergence achieved after 33 iterations
Coefficient covariance computed using outer product of gradients
MA Backcast: 1/02/2019
Presample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(3) + C(4)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(5)*RESID(-1)/@SQRT(GARCH(-1)) + C(6)*LOG(GARCH(-1)) + C(7)*LOG(GARCH(-2))

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	5.511247	2.582158	2.134357	0.0328
MA(1)	-0.209331	0.078258	-2.674885	0.0075
Variance Equation				
C(3)	4.639645	1.198520	3.871146	0.0001
C(4)	0.571553	0.090439	6.319768	0.0000
C(5)	0.022346	0.068258	0.327375	0.7434
C(6)	0.678221	0.190718	3.556143	0.0004
C(7)	-0.318375	0.178490	-1.783710	0.0745

R-squared	-0.008732	Mean dependent var	5.418327
Adjusted R-squared	-0.012783	S.D. dependent var	56.08676
S.E. of regression	56.44410	Akaike info criterion	10.79317
Sum squared resid	793298.2	Schwarz criterion	10.89149
Log likelihood	-1347.543	Hannan-Quinn criter.	10.83274
Durbin-Watson stat	1.731854		

Inverted MA Roots	.21

Lampiran 5. Pendugaan Model E-GARCH (Lanjutan)

c. Model ARIMA(0,1,1) E-GARCH(2,1)

Dependent Variable: D(BCA)
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)
Date: 06/23/22 Time: 00:20
Sample (adjusted): 1/03/2019 12/19/2019
Included observations: 251 after adjustments
Convergence achieved after 36 iterations
Coefficient covariance computed using outer product of gradients
MA Backcast: 1/02/2019
Presample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(3) + C(4)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(5)*ABS(RESID(-2)/@SQRT(GARCH(-2))) + C(6)*RESID(-1) /@SQRT(GARCH(-1)) + C(7)*LOG(GARCH(-1))

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	5.455924	2.684031	2.032735	0.0421
MA(1)	-0.165918	0.076670	-2.164047	0.0305
Variance Equation				
C(3)	6.116692	2.185798	2.798379	0.0051
C(4)	0.516381	0.100233	5.151830	0.0000
C(5)	0.362206	0.160384	2.258374	0.0239
C(6)	0.042453	0.080459	0.527634	0.5978
C(7)	0.144816	0.283727	0.510408	0.6098

R-squared	-0.000669	Mean dependent var	5.418327
Adjusted R-squared	-0.004688	S.D. dependent var	56.08676
S.E. of regression	56.21807	Akaike info criterion	10.79102
Sum squared resid	786957.5	Schwarz criterion	10.88934
Log likelihood	-1347.273	Hannan-Quinn criter.	10.83058
Durbin-Watson stat	1.809108		

Inverted MA Roots	.17

d. Model ARIMA(0,1,1) E-GARCH(2,2)

Dependent Variable: D(BCA)
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)
Date: 06/23/22 Time: 00:20
Sample (adjusted): 1/03/2019 12/19/2019
Included observations: 251 after adjustments
Convergence achieved after 56 iterations
Coefficient covariance computed using outer product of gradients
MA Backcast: 1/02/2019
Presample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(3) + C(4)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(5)*ABS(RESID(-2)/@SQRT(GARCH(-2))) + C(6)*RESID(-1) /@SQRT(GARCH(-1)) + C(7)*LOG(GARCH(-1)) + C(8) *LOG(GARCH(-2))

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	5.527832	2.664095	2.074938	0.0380
MA(1)	-0.187766	0.079332	-2.366838	0.0179
Variance Equation				
C(3)	6.013579	2.374237	2.532847	0.0113
C(4)	0.537546	0.105606	5.090101	0.0000
C(5)	0.241434	0.300223	0.804183	0.4213
C(6)	0.026370	0.082754	0.318652	0.7500
C(7)	0.399790	0.516058	0.774700	0.4385
C(8)	-0.233274	0.293802	-0.793982	0.4272

R-squared	-0.004288	Mean dependent var	5.418327
Adjusted R-squared	-0.008321	S.D. dependent var	56.08676
S.E. of regression	56.31963	Akaike info criterion	10.79794
Sum squared resid	789803.4	Schwarz criterion	10.91030
Log likelihood	-1347.141	Hannan-Quinn criter.	10.84315
Durbin-Watson stat	1.770353		

Inverted MA Roots	.19

Lampiran 6. Uji Diagnostik Model E-GARCH

a. Uji Ljung Box Model ARIMA(0,1,1) E-GARCH(1,1)

Date: 06/14/22 Time: 15:29
Sample: 1/02/2019 12/19/2019
Included observations: 251

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	0.031	0.031	0.2448	0.621
		2	0.055	0.054	1.0203	0.600
		3	-0.032	-0.035	1.2794	0.734
		4	-0.060	-0.061	2.2018	0.699
		5	0.012	0.019	2.2372	0.815
		6	-0.015	-0.010	2.2918	0.891
		7	-0.011	-0.016	2.3207	0.940
		8	-0.000	-0.001	2.3207	0.970
		9	-0.045	-0.043	2.8597	0.970
		10	0.042	0.042	3.3198	0.973
		11	0.069	0.071	4.5667	0.950
		12	0.053	0.042	5.3175	0.947
		13	-0.032	-0.046	5.5827	0.960
		14	-0.044	-0.038	6.1015	0.964
		15	0.006	0.023	6.1111	0.978
		16	-0.102	-0.099	8.9467	0.916
		17	-0.063	-0.068	10.039	0.902
		18	0.064	0.080	11.155	0.888
		19	0.080	0.089	12.904	0.843
		20	0.121	0.100	16.949	0.656
		21	-0.017	-0.036	17.033	0.709
		22	-0.054	-0.071	17.833	0.716
		23	-0.040	-0.035	18.272	0.743
		24	-0.084	-0.065	20.259	0.682
		25	0.027	0.027	20.464	0.722
		26	-0.017	-0.009	20.545	0.765
		27	-0.069	-0.054	21.895	0.743
		28	-0.034	-0.011	22.216	0.771
		29	-0.033	-0.028	22.535	0.797
		30	-0.041	-0.094	23.010	0.815
		31	-0.010	-0.042	23.036	0.848
		32	-0.009	-0.002	23.058	0.876
		33	-0.068	-0.066	24.386	0.861
		34	0.005	0.033	24.392	0.888
		35	-0.038	-0.006	24.816	0.899
		36	-0.053	-0.046	25.656	0.900

b. Model ARIMA(0,1,1) E-GARCH(1,1)

Heteroskedasticity Test: ARCH

F-statistic	0.239491	Prob. F(1,248)	0.6250
Obs*R-squared	0.241190	Prob. Chi-Square(1)	0.6233

Test Equation:
Dependent Variable: WGT_RESID^2
Method: Least Squares
Date: 09/02/22 Time: 12:46
Sample (adjusted): 1/04/2019 12/19/2019
Included observations: 250 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.966562	0.133333	7.249213	0.0000
WGT_RESID^2(-1)	0.031055	0.063457	0.489378	0.6250

R-squared	0.000965	Mean dependent var	0.997690
Adjusted R-squared	-0.003064	S.D. dependent var	1.849996
S.E. of regression	1.852828	Akaike info criterion	4.079271
Sum squared resid	851.3769	Schwarz criterion	4.107443
Log likelihood	-507.9089	Hannan-Quinn criter.	4.090609
F-statistic	0.239491	Durbin-Watson stat	1.999921
Prob(F-statistic)	0.625006		

Lampiran 7. Validasi Data Menggunakan Data *Testing*

Date	Data Aktual (Rupiah)	Data Hasil Ramalan (Rupiah)	
		Model GARCH	Model E-GARCH
12/20/2019	6660	6625.8251	6626.9918
12/23/2019	6660	6658.0466	6657.9490
12/24/2019	6617	6664.5085	6664.7808
12/25/2019	6617	6631.9366	6633.2739
12/26/2019	6680	6625.4044	6626.3207
12/27/2019	6695	6673.9513	6673.3872
12/30/2019	6685	6695.6790	6695.4638
12/31/2019	6617	6692.0419	6692.5426
1/1/2020	6617	6637.4583	6639.4005
1/2/2020	6690	6626.5118	6627.6728
1/3/2020	6800	6682.1680	6681.4787
1/6/2020	6735	6781.2696	6779.0775
1/7/2020	6740	6749.1794	6749.9607
1/8/2020	6680	6746.7411	6747.4316
1/9/2020	6740	6698.2849	6700.1146
1/10/2020	6725	6736.5345	6736.4313
1/13/2020	6745	6732.2134	6732.7561
1/14/2020	6870	6747.3359	6747.5314
1/15/2020	6835	6850.3005	6848.2063
1/16/2020	6850	6842.9687	6843.1479
1/17/2020	6875	6853.4901	6853.7212
1/20/2020	6835	6875.5865	6875.5375
1/21/2020	6830	6848.0397	6849.1794
1/22/2020	6840	6838.5180	6839.4660
1/23/2020	6840	6844.6030	6845.1156
1/24/2020	6810	6845.8233	6846.3623
1/27/2020	6840	6822.0844	6823.2581
1/28/2020	6790	6841.3073	6841.5387
1/29/2020	6785	6805.1897	6806.6073
1/30/2020	6740	6793.9492	6795.0018
1/31/2020	6480	6755.7195	6757.3715
3/2/2020	6080	6302.2662	6304.2645
3/3/2020	6320	6149.4747	6134.7253
3/4/2020	6440	6286.6913	6284.3460
3/5/2020	6435	6414.1549	6410.8828
3/6/2020	6200	6435.7198	6434.9111
3/9/2020	5785	6262.1728	6257.0749
3/10/2020	5925	5883.5896	5894.4135
3/11/2020	5850	5921.5956	5923.4834
3/12/2020	5560	5869.2584	5871.4501
	MAPE	1.1329%	1.1252%
	RMSEP	113.1625	113.0401