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LAMPIRAN

LAMPIRAN 1 DATA

Periode	US$	Periode	US$	Periode	US$
Jan-99	2373.5	Sep-06	7242.8	May-14	12447.9
Feb-99	2615.9	Oct-06	7119.6	Jun-14	12623.5
Mar-99	3307.1	Nov-06	7167.7	Jul-14	11627.8
Apr-99	3238.1	Dec-06	7715.1	Aug-14	11883.5
May-99	3358.2	Jan-07	6801.3	Sep-14	12653.2
Jun-99	3038.2	Feb-07	6726.1	Oct-14	12879.6
Jul-99	3367.8	Mar-07	7490.2	Nov-14	11509.3
Aug-99	3609.7	Apr-07	7376.5	Dec-14	12268.4
Sep-99	3577.9	May-07	8015.8	Jan-15	11285.9
Oct-99	3579.1	Jun-07	7730.4	Feb-15	10419.4
Nov-99	3468.5	Jul-07	8213.3	Mar-15	11645.2
Dec-99	3339.2	Aug-07	7740.3	Apr-15	11646.4
Jan-00	3249.4	Sep-07	7437.5	May-15	11361.9
Feb-00	3693.4	Oct-07	8319	Jun-15	12074.2
Mar-00	3847.5	Nov-07	7737	Jul-15	10043.9
Apr-00	4024.4	Dec-07	8425	Aug-15	11195.2
May-00	3853.4	Jan-08	8947.7	Sep-15	11134.8
Jun-00	4160.4	Feb-08	8164.4	Oct-15	10742.2
Jul-00	4233.5	Mar-08	9241.7	Nov-15	9625.1
Aug-00	4265.2	Apr-08	8440.5	Dec-15	10617.6
Sep-00	4433.4	May-08	9684.8	Jan-16	9473.9
Oct-00	4164.2	Jun-08	9823.5	Feb-16	10203.4
Nov-00	3919	Jul-08	9645.3	Mar-16	10572.8
Dec-00	3913.6	Aug-08	9510.5	Apr-16	10798
Jan-01	3675.3	Sep-08	9821.7	May-16	10559.5
Feb-01	3632.4	Oct-08	8904.4	Jun-16	12018.8
Mar-01	3863.3	Nov-08	8220.2	Jul-16	8650.9
Apr-01	3742.4	Dec-08	7489.5	Aug-16	11563.1
May-01	3700.5	Jan-09	6254.6	Sep-16	11518.3
Jun-01	3758.4	Feb-09	6109.9	Oct-16	11687.9
Jul-01	3782.2	Mar-09	7333.1	Nov-16	12399.9
Aug-01	4113.3	Apr-09	7200	Dec-16	12582.2

Sep-01	3382.5	May-09	8072.1	Jan-17	12119.1
Oct-01	3624.4	Jun-09	7929.4	Feb-17	11407.3
Nov-01	3075.9	Jul-09	8195.2	Mar-17	13202.2
Dec-01	3351	Aug-09	8890.1	Apr-17	12233.5
Jan-02	3222.3	Sep-09	8092.9	May-17	13039.5
Feb-02	3384.7	Oct-09	10131.2	Jun-17	10385.1
Mar-02	3523.5	Nov-09	8438	Jul-17	12446.1
Apr-02	3747.8	Dec-09	10845.2	Aug-17	13954.4
May-02	3735.2	Jan-10	9251	Sep-17	13125.2
Jun-02	4127.6	Feb-10	8991.2	Oct-17	13764.4
Jul-02	4041.9	Mar-10	10605.8	Nov-17	14039
Aug-02	3911.1	Apr-10	9830.6	Dec-17	13368.1
Sep-02	4069.5	May-10	10249.9	Jan-18	13233.6
Oct-02	4182.9	Jun-10	10428.6	Feb-18	12743.6
Nov-02	3340	Jul-10	10605.5	Mar-18	14254.5
Dec-02	3683.4	Aug-10	11733	Apr-18	13317.4
Jan-03	3799.9	Sep-10	10098.7	May-18	14565.2
Feb-03	3721.3	Oct-10	11557.8	Jun-18	11295
Mar-03	3865.6	Nov-10	12816.9	Jul-18	14868.2
Apr-03	3931.2	Dec-10	13570.6	Aug-18	14441.4
May-03	3956.2	Jan-11	11991.2	Sep-18	13636.1
Jun-03	4202	Feb-11	11802.8	Oct-18	14363.8
Jul-03	4272	Mar-11	13304.1	Nov-18	13538.8
Aug-03	3769.2	Apr-11	12925.9	Dec-18	12583.3
Sep-03	3896.3	May-11	14214.6	Jan-19	12896.8
Oct-03	4045.2	Jun-11	14795.9	Feb-19	11737.8
Nov-03	3873.9	Jul-11	13616	Mar-19	13370.4
Dec-03	4058	Aug-11	14556.2	Apr-19	12380
Jan-04	3842.6	Sep-11	13612.4	May-19	13697.6
Feb-04	3766.5	Oct-11	13895.1	Jun-19	11049.2
Mar-04	3888.3	Nov-11	13712.7	Jul-19	13837.9
Apr-04	4093.6	Dec-11	13592.7	Aug-19	13419.1
May-04	4231.9	Jan-12	12425.4	Sep-19	13277.1
Jun-04	4578.8	Feb-12	12340	Oct-19	14021.5

Jul-04	4713.5	Mar-12	13765.4	Nov-19	12910.8
Aug-04	5065.6	Apr-12	12612.5	Dec-19	13295.5
Sep-04	5766.3	May-12	13104.7	Jan-20	12821.1
Oct-04	5978.3	Jun-12	12541.8	Feb-20	13236.9
Nov-04	4727.8	Jul-12	13165.4	Mar-20	13413.9
Dec-04	5286.1	Aug-12	11264	Apr-20	11597.7
Jan-05	4907.7	Sep-12	13127.6	May-20	9891.7
Feb-05	5039.6	Oct-12	12669.4	Jun-20	11439.4
Mar-05	5590	Nov-12	13599.9	Jul-20	13029.5
Apr-05	5221.6	Dec-12	12427	Aug-20	12455.7
May-05	5781.7	Jan-13	12721.8	Sep-20	13288.9
Jun-05	5377.4	Feb-13	12448.1	Oct-20	13748.9
Jul-05	5529.2	Mar-13	12096.3	Nov-20	14496.2
Aug-05	5477	Apr-13	12308.8	Dec-20	15520.8
Sep-05	5802.1	May-13	13207.1	Jan-21	14416.4
Oct-05	6131.8	Jun-13	11958.5	Feb-21	14394.8
Nov-05	5271.7	Jul-13	12805.3	Mar-21	17446.9
Dec-05	6298.6	Aug-13	10363.2	Apr-21	17532.4
Jan-06	5733.8	Sep-13	12292.1	May-21	15967.4
Feb-06	5760.3	Oct-13	12983.1	Jun-21	17308.5
Mar-06	5808.4	Nov-13	13171.7	Jul-21	18390.8
Apr-06	5949.3	Dec-13	13562.7	Aug-21	20398.6
May-06	6580.4	Jan-14	11970.6	Sep-21	19684
Jun-06	6671.2	Feb-14	11904.9	Oct-21	21026.7
Jul-06	6781.8	Mar-14	12551.3	Nov-21	21505.9
Aug-06	7058.8	Apr-14	11641.1	Dec-21	21289.7

LAMPIRAN 2 OUTPUT NILAI KOEFISIEN WAVELET PADA FILTER HAAR

	modwt_Haar@W$W1	modwt_Haar@W$W2	modwt_Haar@W$W3	modwt_Haar@W$W4	modwt_Haar@W$W5	modwt_Haar@W$W6	modwt_Haar@W$W7	modwt_Haar@W$W8
1	-9458.10	-4717.35	-1198.262	1153.369	1953.612	809.531	869.613	3193.854
2	121.20	-9451.55	-3964.387	12.606	1521.341	687.741	823.019	3104.746
3	345.60	-4435.05	-6628.625	-1173.538	1151.109	500.728	761.482	3026.598
4	-34.50	388.95	-8996.462	-2550.931	701.597	328.573	703.903	2940.814
5	60.05	168.325	-6709.562	-3900.519	320.425	155.497	647.125	2861.942
6	-160.00	-37.2	-4355.425	-5439.294	-46.134	-56.964	601.177	2779.443
7	164.80	-47.575	-2072.987	-6826.612	-627.859	-201.52	528.334	2700.559
8	120.95	145.275	229.912	-8166.444	-1195.347	-369.455	471.58	2623.086
9	-15.90	195.4	134.287	-7241.55	-1680.841	-510.467	392.863	2554.443
10	0.60	44.875	149.113	-6263.062	-2237.122	-705.93	354.964	2486.699
11	-55.30	-35	154.112	-5310.244	-2858.972	-876.448	295.134	2407.48
12	-64.65	-87.325	73.85	-4231.394	-3667.106	-968.664	201.719	2338.056
13	-44.90	-114.75	5.325	-3217.831	-4486.697	-1021.927	124.404	2261.582
14	222.00	33.775	-48	-2052.6	-5327.966	-1106.63	36.173	2192.184
15	77.05	238.075	-13.212	-888.987	-6144.678	-1234.325	-50.273	2116.374
16	88.45	232.275	106.25	241.931	-6960.281	-1351.808	-139.709	2057.184
17	-85.5	84.225	222.813	183.875	-6572.93	-1500.1	-213.82	1982.264
18	153.5	35.475	266.9	160.006	-6176.76	-1665.63	-281.456	1912.757
19	36.55	129.025	267.775	197.731	-5798.15	-1829.76	-364.859	1836.809
20	15.85	121.225	212.225	249.287	-5382.22	-2040.06	-442.536	1771.024
21	84.1	76.175	209.225	330.087	-5003.05	-2193.72	-536.092	1703.543
22	-134.6	24.725	151.325	318.562	-4612.97	-2402.01	-582.793	1638.682
23	-122.6	-153.85	63.763	293.05	-4155.77	-2653.67	-689.989	1575.277
24	-2.7	-191.25	-10.287	260.206	-3711.19	-2914.76	-788.898	1509.68
25	-119.15	-123.575	-177.55	231.856	-3320.97	-3143.25	-870.069	1436.753
26	-21.45	-131.225	-244.5	162.525	-2890.26	-3402.95	-972.699	1373.855
27	115.45	-23.3	-212.15	91.575	-2411.6	-3705.76	-1054.02	1301.952
28	-60.45	74.5	-189.6	1.025	-1865.9	-4088.12	-1140.43	1249.996
29	-20.95	-13.2	-91.688	-118.781	-1338.22	-4443.92	-1217	1183.263
30	28.95	-36.7	-9.462	-173.569	-794.522	-4858.87	-1269.61	1111.05
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
276	-108.1	521.225	1430.125	2170.394	2281.947	1020.522	919.991	3278.316

LAMPIRAN 3 OUTPUT NILAI KOEFISIEN WAVELET PADA FILTER DAUBECHIES 4

	modwt_D4@W$W1	modwt_D4@W$W2	modwt_D4@W$W3	modwt_D4@W$W4	modwt_D4@W$W5	modwt_D4@W$W6	modwt_D4@W$W7	modwt_D4@W$W8
1	1948.65	1246.708	-108.36	-1150.694	360.891	-989.415	286.468	3371.786
2	4633.04	1769.404	452.399	-1316.409	262.265	-1032.668	364.017	3345.903
3	-6583.85	3110.794	791.371	-1415.908	185.421	-1070.019	437.813	3319.154
4	-83.71	4887.734	1375.518	-1252.635	149.509	-1088.413	511.601	3291.031
5	242.31	1141.405	2229.246	-904.909	76.628	-1104.674	581.032	3261.032
6	-24.31	-5972.035	3077.142	-419.713	65.075	-1117	645.563	3230.252
7	90.85	-5252.643	4244.483	83.606	58.367	-1106.39	708.181	3197.888
8	-213.82	-160.544	5257.15	675.742	13.753	-1087.268	767.103	3165.545
9	55.00	767.373	4305.013	1197.525	-8.432	-1074.228	819.89	3130.556
10	90.45	-68.235	1980.362	1763.335	-88.114	-1079.099	866.722	3091.169
11	-1.04	-156.528	-1228.797	2383.25	-153.715	-1068.709	910.918	3050.051
12	39.89	20.914	-5114.833	2917.916	-169.758	-1061.752	949.867	3005.177
13	2.77	186.491	-6092.1	3419.095	-201.047	-1039.035	997.425	2962.091
14	-62.34	115.537	-5171.922	4004.412	-198.354	-991.837	1052.155	2920.513
15	-155.77	-4.305	-3411.898	4556.162	-159.427	-941.167	1104.902	2876.814
16	96.92	-98.826	-621.535	5048.675	-112.465	-896.971	1157.523	2831.961
17	24.049	-203.036	437.15	5064.574	-81.261	-847.838	1208.223	2784.83
18	75.07	-152.629	575.349	4630.14	10.857	-799.97	1257.026	2735.439
19	-141.837	55.342	536.405	3900.553	101.901	-732.755	1306.97	2685.556
20	83.667	147.752	43.594	2818.55	184.497	-662.875	1358.187	2634.368
21	1.648	27.338	-119.046	1529.184	312.868	-590.345	1408.06	2579.943
22	-6.591	-60.132	-151.342	-95.684	371.599	-520.435	1454.404	2521.721
23	147.179	36.784	-199.384	-1952.774	504.505	-439.907	1501.351	2463.605
24	-30.139	118.599	-140.245	-3984.596	700.658	-347.47	1548.043	2403.281
25	-60.581	141.932	-17.883	-5071.563	898.007	-234.343	1596.696	2346.424
26	61.656	149.739	106.424	-5454.415	1151.318	-106.816	1646.566	2293.848
27	-91.785	13.867	195.999	-5500.769	1418.276	10.538	1690.966	2240.027
28	-61.313	-98.219	218.335	-5058.247	1738.891	113.59	1731.785	2187.155
29	112.913	-80.223	238.347	-4480.09	2155.695	219.412	1766.225	2134.295
30	-36.111	-102.847	237.212	-3605.641	2615.152	319.898	1795.875	2080.487
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
276	358.524	467.065	-261.907	-1016.99	437.173	-919.546	215.968	3397.235

LAMPIRAN 10 SYNTAKS RSTUDIO

```
# install.packages("splus2R")
# install.packages("devtools")
# devtools::install_github("spkaluzny/ifultools")
# install.packages("C:/Users/zyrex/Downloads/wmtsa_2.0-3.tar.gz",
repos = NULL, type = "source")

# Input Data #
=====================================================================
library(readxl)
nonmigass <- read_excel("~/THESIS ^^/a.proposal/nonmigass.xlsx")
View(nonmigass)
x <- as.ts(nonmigass$`US$`)
t <- seq(from=1,to=276,by=1)
plot.ts(x)
plot.ts(x, type="l", col="blue", xlab="Bulanan", ylab="US$",
main="US$ Bulanan")
dim(nonmigass)

#analisis deskriptif
Summary (nonmigass)

# Transformasi MODWT pada filter Haar dan Daubechies 4 #
======================
library(wavelets)
lvl = 8

## Filter Haar ##
modwt_Haar = modwt(x, filter="haar", n.levels=lvl,
boundary="periodic", fast=TRUE)
koef_MODWT_Haar =
cbind(modwt_Haar@W$W1,modwt_Haar@W$W2,modwt_Haar@W$W3,modwt_Haar@
W$W4,

modwt_Haar@W$W5,modwt_Haar@W$W6,modwt_Haar@W$W7,modwt_Haar@W$W8)
koef_MODWT_Haar

## Filter Daubechies 4 ##
modwt_D4 = modwt(x, filter="d4", n.levels=lvl,
boundary="periodic", fast=TRUE)
koef_MODWT_D4 =
cbind(modwt_D4@W$W1,modwt_D4@W$W2,modwt_D4@W$W3,modwt_D4@W$W4,
```

```
modwt_D4@W$W5,modwt_D4@W$W6,modwt_D4@W$W7,modwt_D4@W$W8)

koef_MODWT_D4

# Filter Haar menggunakan parameter Minimax Threshold #
=======================
library(wmtsa)
win.graph()

## Fungsi Soft Thresholding ##
Minimax_Soft = matrix(0,nrow=276,ncol=lvl)
for (j in 1:lvl) {
  Minimax_L = wavShrink(x, wavelet="haar", shrink.fun="soft",
thresh.fun="minimax",
                        threshold=NULL, n.level=j, xform="modwt",
noise.variance=0.0,
                        reflect=TRUE)
  Minimax_Soft[,j] = Minimax_L
}
Minimax_Soft

par(mfrow=c(2,2))
par(new=T)
plot(t, Minimax_Soft[,1], type="l", col=3, ylim=c(min(x),max(x)),
ylab="",xlab="") ;mtext("Minimax Soft Level 1", side=3, line=0.3)
plot(t, Minimax_Soft[,2], type="l", col=3, ylim=c(min(x),max(x)),
ylab="",xlab="") ;mtext("Minimax Soft Level 2", side=3, line=0.3)
plot(t, Minimax_Soft[,3], type="l", col=3, ylim=c(min(x),max(x)),
ylab="",xlab="") ;mtext("Minimax Soft Level 3", side=3, line=0.3)
plot(t, Minimax_Soft[,4], type="l", col=3, ylim=c(min(x),max(x)),
ylab="",xlab="") ;mtext("Minimax Soft Level 4", side=3, line=0.3)
plot(t, Minimax_Soft[,5], type="l", col=3, ylim=c(min(x),max(x)),
ylab="",xlab="") ;mtext("Minimax Soft Level 5", side=3, line=0.3)
plot(t, Minimax_Soft[,6], type="l", col=3, ylim=c(min(x),max(x)),
ylab="",xlab="") ;mtext("Minimax Soft Level 6", side=3, line=0.3)
plot(t, Minimax_Soft[,7], type="l", col=3, ylim=c(min(x),max(x)),
ylab="",xlab="") ;mtext("Minimax Soft Level 7", side=3, line=0.3)

## Fungsi Hard Thresholding ##
Minimax_Hard = matrix(0,nrow=276,ncol=lvl)
for (j in 1:lvl) {
```

```
  Minimax_K = wavShrink(x, wavelet="haar", shrink.fun="hard",
thresh.fun="minimax",
                        threshold=NULL, n.level=j, xform="modwt",
noise.variance=0.0,
                        reflect=TRUE)
  Minimax_Hard[,j] = Minimax_K
}
Minimax_Hard

par(mfrow=c(2,2))
par(new=T)
plot(t, Minimax_Hard[,1], type="l", col=3, ylim=c(min(x),max(x)),
ylab="",xlab="") ;mtext("Minimax Hard level 1", side=3, line=0.3)
plot(t, Minimax_Hard[,2], type="l", col=3, ylim=c(min(x),max(x)),
ylab="",xlab="") ;mtext("Minimax Hard level 2", side=3, line=0.3)
plot(t, Minimax_Hard[,3], type="l", col=3, ylim=c(min(x),max(x)),
ylab="",xlab="") ;mtext("Minimax Hard level 3", side=3, line=0.3)
plot(t, Minimax_Hard[,4], type="l", col=3, ylim=c(min(x),max(x)),
ylab="",xlab="") ;mtext("Minimax Hard level 4", side=3, line=0.3)
plot(t, Minimax_Hard[,5], type="l", col=3, ylim=c(min(x),max(x)),
ylab="",xlab="") ;mtext("Minimax Hard level 5", side=3, line=0.3)
plot(t, Minimax_Hard[,6], type="l", col=3, ylim=c(min(x),max(x)),
ylab="",xlab="") ;mtext("Minimax Hard level 6", side=3, line=0.3)
plot(t, Minimax_Hard[,7], type="l", col=3, ylim=c(min(x),max(x)),
ylab="",xlab="") ;mtext("Minimax Hard level 7", side=3, line=0.3)

## MSE ##
Haar_Minimax_mse = matrix(0,nrow=lvl,ncol=3)
colnames(Haar_Minimax_mse) <- c("Level Resolusi","MSE Soft", "MSE
Hard")
for (j in 1:lvl) {
  mse_L <- (sum((x-Minimax_Soft[,j])^2))/276
  mse_K <- (sum((x-Minimax_Hard[,j])^2))/276

  Haar_Minimax_mse[j,1]=j
  Haar_Minimax_mse[j,2]=mse_L
  Haar_Minimax_mse[j,3]=mse_K
}
Haar_Minimax_mse

# Filter Daubechies 4 menggunakan parameter Minimax Threshold #
=======================
library(wmtsa)
```

```
win.graph()

## Fungsi Soft Thresholding ##
Minimax_Soft2 = matrix(0,nrow=276,ncol=lvl)
for (j in 1:lvl) {
  Minimax_L = wavShrink(x, wavelet="d4", shrink.fun="soft",
thresh.fun="minimax",
                        threshold=NULL, n.level=j, xform="modwt",
noise.variance=0.0,
                        reflect=TRUE)
  Minimax_Soft2[,j] = Minimax_L
}
Minimax_Soft2

par(mfrow=c(2,2))
par(new=T)
plot(t, Minimax_Soft2[,1], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Minimax Soft
Level 1", side=3, line=0.3)
plot(t, Minimax_Soft2[,2], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Minimax Soft
Level 2", side=3, line=0.3)
plot(t, Minimax_Soft2[,3], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Minimax Soft
Level 3", side=3, line=0.3)
plot(t, Minimax_Soft2[,4], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Minimax Soft
Level 4", side=3, line=0.3)
plot(t, Minimax_Soft2[,5], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Minimax Soft
Level 5", side=3, line=0.3)
plot(t, Minimax_Soft2[,6], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Minimax Soft
Level 6", side=3, line=0.3)
plot(t, Minimax_Soft2[,7], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Minimax Soft
Level 7", side=3, line=0.3)


## Fungsi Hard Thresholding ##
Minimax_Hard2 = matrix(0,nrow=276,ncol=lvl)
for (j in 1:lvl) {
```

```
  Minimax_K = wavShrink(x, wavelet="d4", shrink.fun="hard",
thresh.fun="minimax",
                        threshold=NULL, n.level=j, xform="modwt",
noise.variance=0.0,
                        reflect=TRUE)
  Minimax_Hard2[,j] = Minimax_K
}
Minimax_Hard2

par(mfrow=c(2,2))
par(new=T)
plot(t, Minimax_Hard2[,1], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Minimax Hard
level 1", side=3, line=0.3)
plot(t, Minimax_Hard2[,2], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Minimax Hard
level 2", side=3, line=0.3)
plot(t, Minimax_Hard2[,3], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Minimax Hard
level 3", side=3, line=0.3)
plot(t, Minimax_Hard2[,4], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Minimax Hard
level 4", side=3, line=0.3)
plot(t, Minimax_Hard2[,5], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Minimax Hard
level 5", side=3, line=0.3)
plot(t, Minimax_Hard2[,6], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Minimax Hard
level 6", side=3, line=0.3)
plot(t, Minimax_Hard2[,7], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Minimax Hard
level 7", side=3, line=0.3)

## MSE ##
D4_Minimax_mse = matrix(0,nrow=lvl,ncol=3)
colnames(D4_Minimax_mse) <- c("Level Resolusi","MSE Soft", "MSE
Hard")
for (j in 1:lvl) {
  mse_L <- (sum((x-Minimax_Soft2[,j])^2))/276
  mse_K <- (sum((x-Minimax_Hard2[,j])^2))/276

  D4_Minimax_mse[j,1]=j
  D4_Minimax_mse[j,2]=mse_L
```

```
  D4_Minimax_mse[j,3]=mse_K
}
D4_Minimax_mse

# Filter Haar menggunakan parameter Universal Threshold #
======================
library(lmtest)
library(qut)

k_MODWT_Haar = koef_MODWT_Haar
Univ_Haar = matrix(0,nrow = lvl,ncol = 3)
colnames(Univ_Haar) = c("Level Resolusi", "Sigma", "Parameter")
for (j in 1:lvl) {
  sigma_h                  = mad(k_MODWT_Haar[,j])
  parameter_universal_Haar = sigma_h*sqrt(2*(log(276)))
  Univ_Haar[j,1] = j
  Univ_Haar[j,2] = sigma_h
  Univ_Haar[j,3] = parameter_universal_Haar
}
Univ_Haar

## Fungsi Soft Thresholding ##
Error_Haar_L   = matrix(0,nrow=276,ncol=lvl)
Universal_Soft = matrix(0,nrow=276,ncol=lvl)
colnames(Error_Haar_L) = c(1:lvl)
for (j in 1:lvl) {
  Universal_L = wavShrink(x, wavelet="haar", shrink.fun="soft",
thresh.fun="universal",
                          threshold=NULL, n.level=j,
xform="modwt", noise.variance=0.0, reflect=TRUE)
  Universal_Soft[,j]= Universal_L
  Error_Haar_L[,j]  = x-Universal_L
}
Universal_Soft
Error_Haar_L

par(mfrow=c(2,2))
par(new=T)
plot(t, Universal_Soft[,1], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Universal Soft
Level 1", side=3, line=0.3)
```

```
plot(t, Universal_Soft[,2], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Universal Soft
Level 2", side=3, line=0.3)
plot(t, Universal_Soft[,3], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Universal Soft
Level 3", side=3, line=0.3)
plot(t, Universal_Soft[,4], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Universal Soft
Level 4", side=3, line=0.3)
plot(t, Universal_Soft[,5], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Universal Soft
Level 5", side=3, line=0.3)
plot(t, Universal_Soft[,6], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Universal Soft
Level 6", side=3, line=0.3)
plot(t, Universal_Soft[,7], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Universal Soft
Level 7", side=3, line=0.3)

## Uji Normalitas
Uji_Normal_Haar_Soft_Universal = list()
for (j in 1:lvl) {
  L1 = ks.test(Error_Haar_L[,j],"pnorm",0,Univ_Haar[j,2])
  Uji_Normal_Haar_Soft_Universal[[j]] = L1
}
Uji_Normal_Haar_Soft_Universal

## Uji Independensi Ljung-Box
Box_Haar_Soft_Universal = list()
for (j in 1:lvl) {
  B1 = Box.test(Error_Haar_L[,j],lag=48,type="Ljung")
  Box_Haar_Soft_Universal[[j]] = B1
}
Box_Haar_Soft_Universal

## Uji Homogenitas dengan Pearson
Cor_Haar_Soft_Universal = list()
for (j in 1:lvl) {
  C1 = cor.test(Error_Haar_L[,j], x, alternative="two.sided",
method="pearson")
  Cor_Haar_Soft_Universal[[j]] = C1
}
Cor_Haar_Soft_Universal
```

```
## Fungsi Hard Thresholding ##
Error_Haar_K = matrix(0,nrow = 276,ncol=lvl)
Universal_Hard = matrix(0,nrow=276,ncol=lvl)
for (j in 1:lvl) {
  Universal_K = wavShrink(x, wavelet="haar", shrink.fun="hard",
thresh.fun="universal",
                          threshold=NULL, n.level=j,
xform="modwt", noise.variance=0.0, reflect=TRUE)
  Universal_Hard[,j]= Universal_K
  Error_Haar_K[,j] = x-Universal_K
}
Universal_Hard
Error_Haar_K


par(mfrow=c(2,2))
par(new=T)
plot(t, Universal_Hard[,1], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Universal Hard
level 1", side=3, line=0.3)
plot(t, Universal_Hard[,2], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Universal Hard
level 2", side=3, line=0.3)
plot(t, Universal_Hard[,3], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Universal Hard
level 3", side=3, line=0.3)
plot(t, Universal_Hard[,4], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Universal Hard
level 4", side=3, line=0.3)
plot(t, Universal_Hard[,5], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Universal Hard
level 5", side=3, line=0.3)
plot(t, Universal_Hard[,6], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Universal Hard
level 6", side=3, line=0.3)
plot(t, Universal_Hard[,7], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Universal Hard
level 7", side=3, line=0.3)


## Uji Normalitas
Uji_Normal_Haar_Hard_Universal = list()
```

```
for (j in 1:lvl) {
  L1 = ks.test(Error_Haar_K[,j],"pnorm",0,Univ_Haar[j,2])
  Uji_Normal_Haar_Hard_Universal[[j]] = L1
}
Uji_Normal_Haar_Hard_Universal

## Uji Independensi Ljung-Box
Box_Haar_Hard_Universal = list()
for (j in 1:lvl) {
  B1 = Box.test(Error_Haar_K[,j],lag=48,type="Ljung")
  Box_Haar_Hard_Universal[[j]] = B1
}
Box_Haar_Hard_Universal
## Uji Homogenitas dengan Pearson
Cor_Haar_Hard_Universal = list()
for (j in 1:lvl) {
  C1 = cor.test(Error_Haar_K[,j], x, alternative="two.sided",
method="pearson")
  Cor_Haar_Hard_Universal[[j]] = C1
}
Cor_Haar_Hard_Universal

## MSE ##
Haar_Universal_mse = matrix(0,nrow=lvl,ncol=3)
colnames(Haar_Universal_mse) <- c("Level Resolusi","MSE Soft",
"MSE Hard")
for (j in 1:lvl) {
  mse_L3 <- (sum((Error_Haar_L[,j])^2))/276
  mse_K3 <- (sum((Error_Haar_K[,j])^2))/276

  Haar_Universal_mse[j,1]=j
  Haar_Universal_mse[j,2]=mse_L3
  Haar_Universal_mse[j,3]=mse_K3
}
Haar_Universal_mse

# Filter Daubechies 4 menggunakan parameter Universal Threshold #
==============
library(lmtest)
library(qut)
k_MODWT_D4 = koef_MODWT_D4
Univ_D4    = matrix(0,nrow = lvl,ncol = 3)
colnames(Univ_D4) = c("Level Resolusi", "Sigma", "Parameter")
```

```
for (j in 1:lvl) {
  sigma_h                   = mad(k_MODWT_D4[,j])
  parameter_universal_D4 = sigma_h*sqrt(2*(log(276)))
  Univ_D4[j,1] = j
  Univ_D4[j,2] = sigma_h
  Univ_D4[j,3] = parameter_universal_D4
}
Univ_D4

## Fungsi Soft Thresholding ##
Error_D4_L = matrix(0,nrow = 276,ncol=lvl)
Universal_Soft2 = matrix(0,nrow=276,ncol=lvl)
for (j in 1:lvl) {
  Universal_L2 = wavShrink(x, wavelet="d4", shrink.fun="soft",
thresh.fun="universal",
                           threshold=NULL, n.level=j,
xform="modwt", noise.variance=0.0, reflect=TRUE)
  Universal_Soft2[,j] = Universal_L2
  Error_D4_L[,j] = x-Universal_L2
}
Universal_Soft2
Error_D4_L

par(mfrow=c(2,2))
par(new=T)
plot(t, Universal_Soft2[,1], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Universal Soft
Level 1", side=3, line=0.3)
plot(t, Universal_Soft2[,2], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Universal Soft
Level 2", side=3, line=0.3)
plot(t, Universal_Soft2[,3], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Universal Soft
Level 3", side=3, line=0.3)
plot(t, Universal_Soft2[,4], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Universal Soft
Level 4", side=3, line=0.3)
plot(t, Universal_Soft2[,5], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Universal Soft
Level 5", side=3, line=0.3)
plot(t, Universal_Soft2[,6], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Universal Soft
Level 6", side=3, line=0.3)
```

```
plot(t, Universal_Soft2[,7], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Universal Soft
Level 7", side=3, line=0.3)


## Uji Normalitas
Uji_Normal_D4_Soft_Universal = list()
for (j in 1:lvl) {
  L3 = ks.test(Error_D4_L[,j],"pnorm",0,Univ_D4[j,2])
  Uji_Normal_D4_Soft_Universal[[j]] = L3
}
Uji_Normal_D4_Soft_Universal

## Uji Independensi Ljung-Box
Box_D4_Soft_Universal = list()
for (j in 1:lvl) {
  B3 = Box.test(Error_D4_L[,j],lag=48,type="Ljung")
  Box_D4_Soft_Universal[[j]] = B3
}
Box_D4_Soft_Universal

## Uji Homogenitas dengan Pearson
Cor_D4_Soft_Universal = list()
for (j in 1:lvl) {
  C3 = cor.test(Error_D4_L[,j], x, alternative="two.sided",
method="pearson")
  Cor_D4_Soft_Universal[[j]] = C3
}
Cor_D4_Soft_Universal

## Fungsi Hard Thresholding ##
Error_D4_K = matrix(0,nrow = 276,ncol=lvl)
Universal_Hard2 = matrix(0,nrow=276,ncol=lvl)
for (j in 1:lvl) {
  Universal_K2 = wavShrink(x, wavelet="d4", shrink.fun="hard",
thresh.fun="universal",
                           threshold=NULL, n.level=j,
xform="modwt", noise.variance=0.0, reflect=TRUE)
  Universal_Hard2[,j] = Universal_K2
  Error_D4_K[,j] = x-Universal_K2
}
Universal_Hard2
Error_D4_K
```

```
par(mfrow=c(2,2))
par(new=T)
plot(t, Universal_Hard2[,1], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Universal Hard
level 1", side=3, line=0.3)
plot(t, Universal_Hard2[,2], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Universal Hard
level 2", side=3, line=0.3)
plot(t, Universal_Hard2[,3], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Universal Hard
level 3", side=3, line=0.3)
plot(t, Universal_Hard2[,4], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Universal Hard
level 4", side=3, line=0.3)
plot(t, Universal_Hard2[,5], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Universal Hard
level 5", side=3, line=0.3)
plot(t, Universal_Hard2[,6], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Universal Hard
level 6", side=3, line=0.3)
plot(t, Universal_Hard2[,7], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Universal Hard
level 7", side=3, line=0.3)


## Uji Normalitas
Uji_Normal_D4_Hard_Universal = list()
for (j in 1:lvl) {
  L4 = ks.test(Error_D4_K[,j],"pnorm",0,Univ_D4[j,2])
  Uji_Normal_D4_Hard_Universal[[j]] = L4
}
Uji_Normal_D4_Hard_Universal

## Uji Independensi Ljung-Box
Box_D4_Hard_Universal = list()
for (j in 1:lvl) {
  B4 = Box.test(Error_D4_K[,j],lag=48,type="Ljung")
  Box_D4_Hard_Universal[[j]] = B4
}
Box_D4_Hard_Universal

## Uji Homogenitas dengan Pearson
```

```
Cor_D4_Hard_Universal = list()
for (j in 1:lvl) {
  C4 = cor.test(Error_D4_K[,j], x, alternative="two.sided",
method="pearson")
  Cor_D4_Hard_Universal[[j]] = C4
}
Cor_D4_Hard_Universal

## MSE ##
D4_Universal_mse = matrix(0,nrow=lvl,ncol=3)
colnames(D4_Universal_mse) <- c("Level Resolusi","MSE Soft", "MSE
Hard")
for (j in 1:lvl) {
  mse_L4 <- (sum((Error_D4_L[,j])^2))/276
  mse_K4 <- (sum((Error_D4_K[,j])^2))/276

  D4_Universal_mse[j,1]=j
  D4_Universal_mse[j,2]=mse_L4
  D4_Universal_mse[j,3]=mse_K4
}
D4_Universal_mse

# Filter Haar menggunakan parameter Adaptive Threshold #
=======================
library(wavethresh)
koef_Haar = koef_MODWT_Haar

Adaptive_Soft = matrix(0,nrow = 276,ncol = lvl)
for (j in 1:lvl) {
  Adaptive_L = wavShrink(x, wavelet="haar", shrink.fun="soft",
thresh.fun="adaptive",
                         threshold=NULL, n.level=j,
xform="modwt", noise.variance=0.0, reflect=TRUE)
  Adaptive_Soft[,j]=Adaptive_L
}
Adaptive_Soft

par(mfrow=c(2,2))
par(new=T)
plot(t, Adaptive_Soft[,1], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Adaptive Soft
Level 1", side=3, line=0.3)
```

```
plot(t, Adaptive_Soft[,2], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Adaptive Soft
Level 2", side=3, line=0.3)
plot(t, Adaptive_Soft[,3], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Adaptive Soft
Level 3", side=3, line=0.3)
plot(t, Adaptive_Soft[,4], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Adaptive Soft
Level 4", side=3, line=0.3)
plot(t, Adaptive_Soft[,5], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Adaptive Soft
Level 5", side=3, line=0.3)
plot(t, Adaptive_Soft[,6], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Adaptive Soft
Level 6", side=3, line=0.3)
plot(t, Adaptive_Soft[,7], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Adaptive Soft
Level 7", side=3, line=0.3)


Haar_Adaptive_mse = matrix(0,nrow=lvl,ncol=3)
colnames(Haar_Adaptive_mse) <- c("Level Resolusi","SURE", "MSE
Soft")
for (j in 1:lvl) {
  mse_L <- (sum((x-Adaptive_Soft[,j])^2))/276
  sr     <- sure(koef_Haar[,j])
  Haar_Adaptive_mse[j,1]= j
  Haar_Adaptive_mse[j,2]= sr
  Haar_Adaptive_mse[j,3]= mse_L
}
Haar_Adaptive_mse

# Filter Daubechies 4 menggunakan parameter Adaptive Threshold #
===============
library(wavethresh)
koef_D4 = koef_MODWT_D4

Adaptive_Soft2 = matrix(0,nrow = 276,ncol = lvl)
for (j in 1:lvl) {
  Adaptive_L2 = wavShrink(x, wavelet="d4", shrink.fun="soft",
thresh.fun="adaptive",
                          threshold=NULL, n.level=j,
xform="modwt", noise.variance=0.0, reflect=TRUE)
```

```
  Adaptive_Soft2[,j]=Adaptive_L2
}
Adaptive_Soft2

par(mfrow=c(2,2))
par(new=T)
plot(t, Adaptive_Soft2[,1], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Adaptive Soft
Level 1", side=3, line=0.3)
plot(t, Adaptive_Soft2[,2], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Adaptive Soft
Level 2", side=3, line=0.3)
plot(t, Adaptive_Soft2[,3], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Adaptive Soft
Level 3", side=3, line=0.3)
plot(t, Adaptive_Soft2[,4], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Adaptive Soft
Level 4", side=3, line=0.3)
plot(t, Adaptive_Soft2[,5], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Adaptive Soft
Level 5", side=3, line=0.3)
plot(t, Adaptive_Soft2[,6], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Adaptive Soft
Level 6", side=3, line=0.3)
plot(t, Adaptive_Soft2[,7], type="l", col=3,
ylim=c(min(x),max(x)), ylab="",xlab="") ;mtext("Adaptive Soft
Level 7", side=3, line=0.3)


D4_Adaptive_mse = matrix(0,nrow=lvl,ncol=3)
colnames(D4_Adaptive_mse) <- c("Level Resolusi","SURE", "MSE
Soft")
for (j in 1:lvl) {
  mse_L <- (sum((x-Adaptive_Soft2[,j])^2))/276
  sr     <- sure(koef_D4[,j])
  Haar_Adaptive_mse[j,1]= j
  Haar_Adaptive_mse[j,2]= sr
  Haar_Adaptive_mse[j,3]= mse_L
}
Haar_Adaptive_mse
```

```
# Peramalan #
=========================================================================
=
library(wmtsa)
win.graph()
par(mfrow=c(2,2))
Minimaxthreshold1K=wavShrink(x,wavelet="haar",shrink.fun="hard",t
hresh.fun="minimax",threshold=NULL,n.level=1,xform="modwt",noise.
variance=0.0,reflect=TRUE)
plot(t,x,ylim=c(min(x),max(x)),type="l",ylab="",xlab="")
par(new=T)
plot(t,minimaxthreshold1K,type="l",col=3,ylim=c(min(x),max(x)),yl
ab="",xlab="")
mtext("Prediksi Nonmigas di Indonesia",side=3,line=0.3)
minimaxthreshold1K
```

LAMPIRAN 11 RIWAYAT HIDUP

A. Data Pribadi

Nama	: Nurfauzul Akbar
Tempat, Tanggal Lahir	: Bima, 29 Oktober 1999
Alamat	: BTN Griya Asri Sakinah, Blok B1 No.10
Kewarganegaraan	: Indonesia
No. Hp/Whatsapp	: 082339749794
e-mail	: akbarnurfauzul@gmail.com

B. Riwayat Pendidikan

- SDN 19 Kota Bima (2005-2011)
- SMPN 1 Kota Bima (2011-2014)
- SMAN 1 Kota Bima (2014-2017)
- S1 di Universitas Negeri Makassar Program Studi Statistika (2017-2021)
- S2 di Universitas Hasanuddin Departemen Statistika Program Studi Magister Statistika (2022-2024)

C. Karya Ilmiah yang telah dipublikasikan

Akbar, N., Herdiani, E. T & Tinungki, G. M. (2024). Wavelet Method Application Thresholding With Maximal Overlap Discrete Wavelet Transform. The Seybold Report Journal (TSRJ).