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COMPUTATIONAL FINANCE & RISK MANAGEMENT

UNIVERSITY of WASHINGTON

Department of Applied Mathematics

Univariate GARCH: Advanced Topics

Amath 546/Econ 589

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Testing for Leverage Effects

```
# Perform Engle-Ng sign bias tests
```

```
> signbias(MSFT.garch11.fit)
```

	t-value	prob	sig
Sign Bias	2.1782	0.02947	**
Negative Sign Bias	0.9318	0.35151	
Positive Sign Bias	0.2251	0.82190	
Joint Effect	5.7250	0.12578	

Weak evidence of
leverage effect for
MSFT returns

```
> signbias(GSPC.garch11.fit)
```

	t-value	prob	sig
Sign Bias	1.409	1.589e-01	
Negative Sign Bias	1.151	2.499e-01	
Positive Sign Bias	3.244	1.192e-03	***
Joint Effect	21.788	7.219e-05	***

EGARCH(1,1)

```
> egarch11.spec = ugarchspec(variance.model=list(model="eGARCH",
+                                           garchOrder=c(1,1)),
+                             mean.model=list(armaOrder=c(0,0)))
> MSFT.egarch11.fit = ugarchfit(egarch11.spec, MSFT.ret)
> MSFT.egarch11.fit
```

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

Conditional Variance Dynamics

```
-----
GARCH Model      : eGARCH(1,1)
Mean Model       : ARFIMA(0,0,0)
Distribution      : norm
```

Optimal Parameters

```
-----
      Estimate  Std. Error  t value  Pr(>|t|)
mu      -0.000007   0.000271  -0.025003  0.980052
omega   -0.083093   0.017115  -4.855053  0.000001
alpha1  -0.051686   0.008287  -6.236700  0.000000
beta1    0.988891   0.002212  446.972786  0.000000
gamma1   0.097162   0.013218   7.350763  0.000000
```

$\alpha_1 < 0 \Rightarrow$ leverage effect.

TGARCH(1,1)/GJR-GARCH(1,1)

```
> gjrgarch11.spec = ugarchspec(variance.model=list(model="gjrGARCH",
+                                           garchOrder=c(1,1)),
+                               mean.model=list(armaOrder=c(0,0)))
> MSFT.gjrgarch11.fit = ugarchfit(gjrgarch11.spec, MSFT.ret)
> MSFT.gjrgarch11.fit
```

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

Conditional Variance Dynamics

```
-----
GARCH Model      : gjrGARCH(1,1)
Mean Model       : ARFIMA(0,0,0)
Distribution      : norm
```

Optimal Parameters

```
-----
      Estimate  Std. Error  t value  Pr(>|t|)
mu      0.000110    0.000276    0.3991  0.689820
omega   0.000005    0.000001    5.0192  0.000001
alpha1  0.021194    0.007888    2.6869  0.007212
beta1   0.929977    0.009514   97.7527  0.000000
gamma1  0.076979    0.013490    5.7063  0.000000
```

$\gamma_1 > 0 \Rightarrow$ leverage effect.

APARCH(1,1,1)

```
> aparch11.1.spec = ugarchspec(variance.model=list(model="apARCH",
+                               garchOrder=c(1,1)),
+                               mean.model=list(armaOrder=c(0,0)),
+                               fixed.pars=list(delta=1))
>
> MSFT.aparch11.1.fit = ugarchfit(aparch11.1.spec, MSFT.ret)
> MSFT.aparch11.1.fit
```

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

Conditional Variance Dynamics

```
-----
GARCH Model      : apARCH(1,1)
Mean Model       : ARFIMA(0,0,0)
Distribution      : norm
```

Optimal Parameters

```
-----
      Estimate  Std. Error  t value  Pr(>|t|)
mu      0.000115    0.000273    0.42062  0.674029
omega   0.000219    0.000045    4.87223  0.000001
alpha1  0.058899    0.007777    7.57342  0.000000
beta1   0.944610    0.007480   126.28947 0.000000
gamma1  0.471093    0.102736    4.58547  0.000005
delta   1.000000           NA           NA           NA
```

$\gamma_1 > 0 \Rightarrow$ leverage effect.

Model Comparison

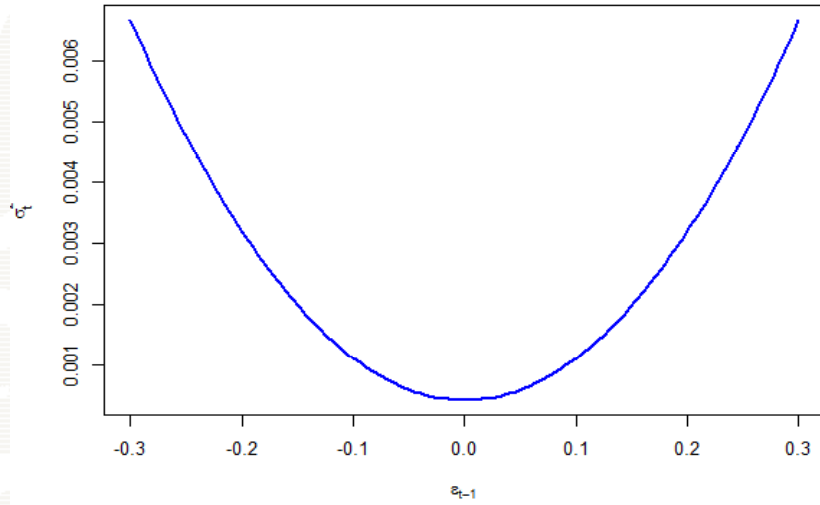
```
# compare information criteria
> model.list = list(garch11 = MSFT.garch11.fit,
+                  egarch11 = MSFT.egarch11.fit,
+                  gjrgarch11 = MSFT.gjrgarch11.fit,
+                  aparch11.1 = MSFT.aparch11.1.fit)
> info.mat = sapply(model.list, infocriteria)
> rownames(info.mat) = rownames(infocriteria(MSFT.garch11.fit))
> info.mat
```

	garch11	egarch11	gjrgarch11	aparch11.1
Akaike	-5.216	-5.232	-5.227	-5.233
Bayes	-5.208	-5.222	-5.217	-5.223
Shibata	-5.216	-5.232	-5.227	-5.233
Hannan-Quinn	-5.213	-5.228	-5.224	-5.230

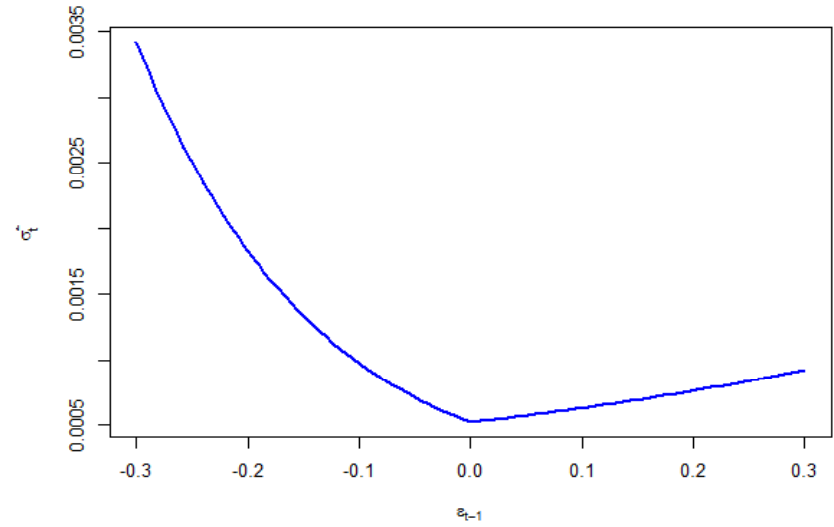
APARCH is the best fitting model

News Impact Curves

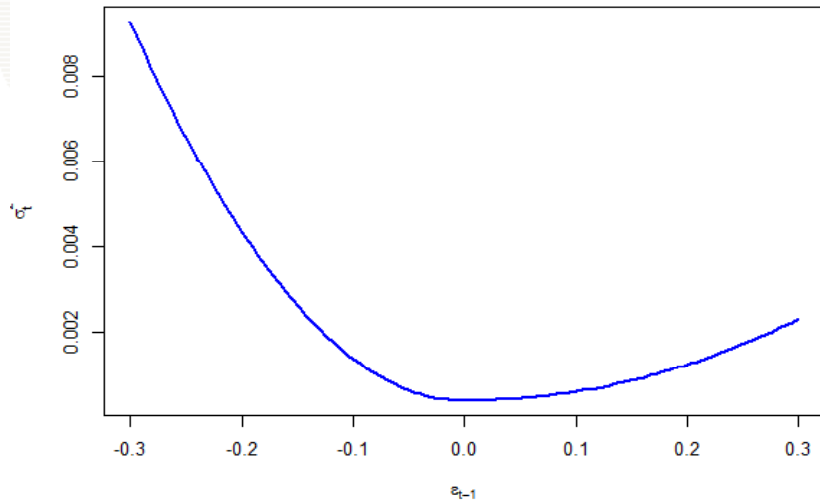
GARCH(1,1)



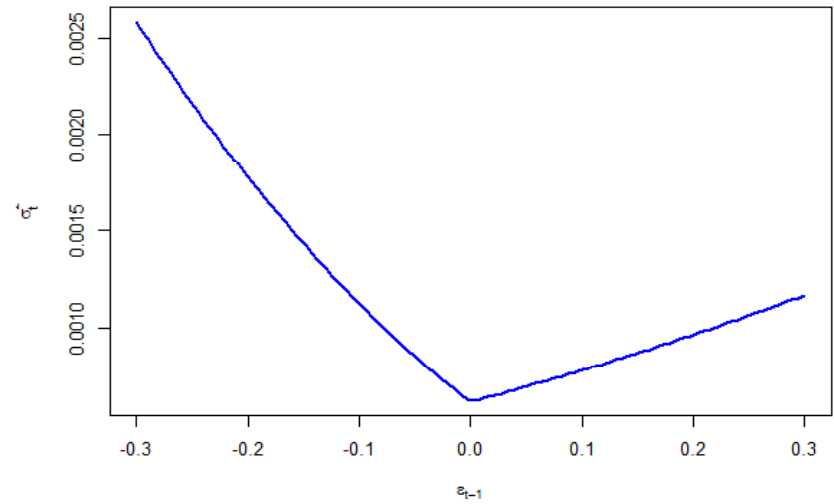
EGARCH(1,1)



TGARCH(1,1)

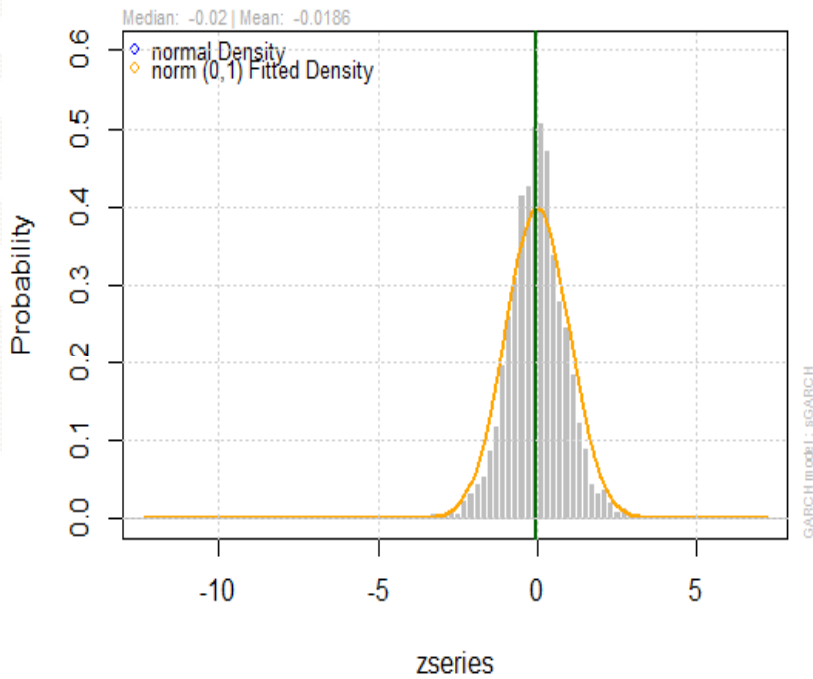


APARCH(1,1,1)

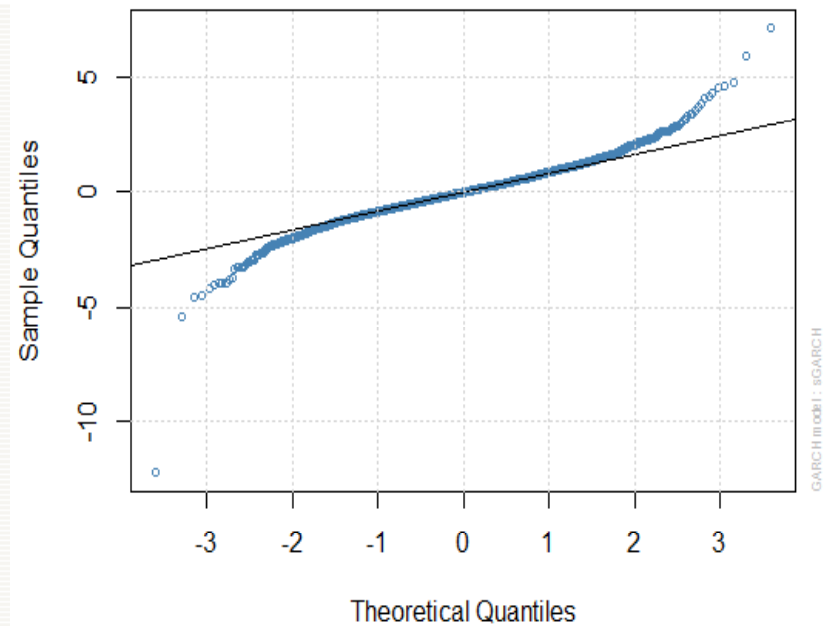


Recall Normal GARCH(1,1)

Empirical Density of Standardized Residuals



norm - QQ Plot



z(t) has fat tails but not much asymmetry except for maybe one point

Student-t GARCH(1,1)

```
> garch11.t.spec = ugarchspec(variance.model = list(garchOrder=c(1,1)),
+                             mean.model = list(armaOrder=c(0,0)),
+                             distribution.model = "std")
> MSFT.garch11.t.fit = ugarchfit(spec=garch11.t.spec, data=MSFT.ret)
> MSFT.garch11.t.fit
```

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

Conditional Variance Dynamics

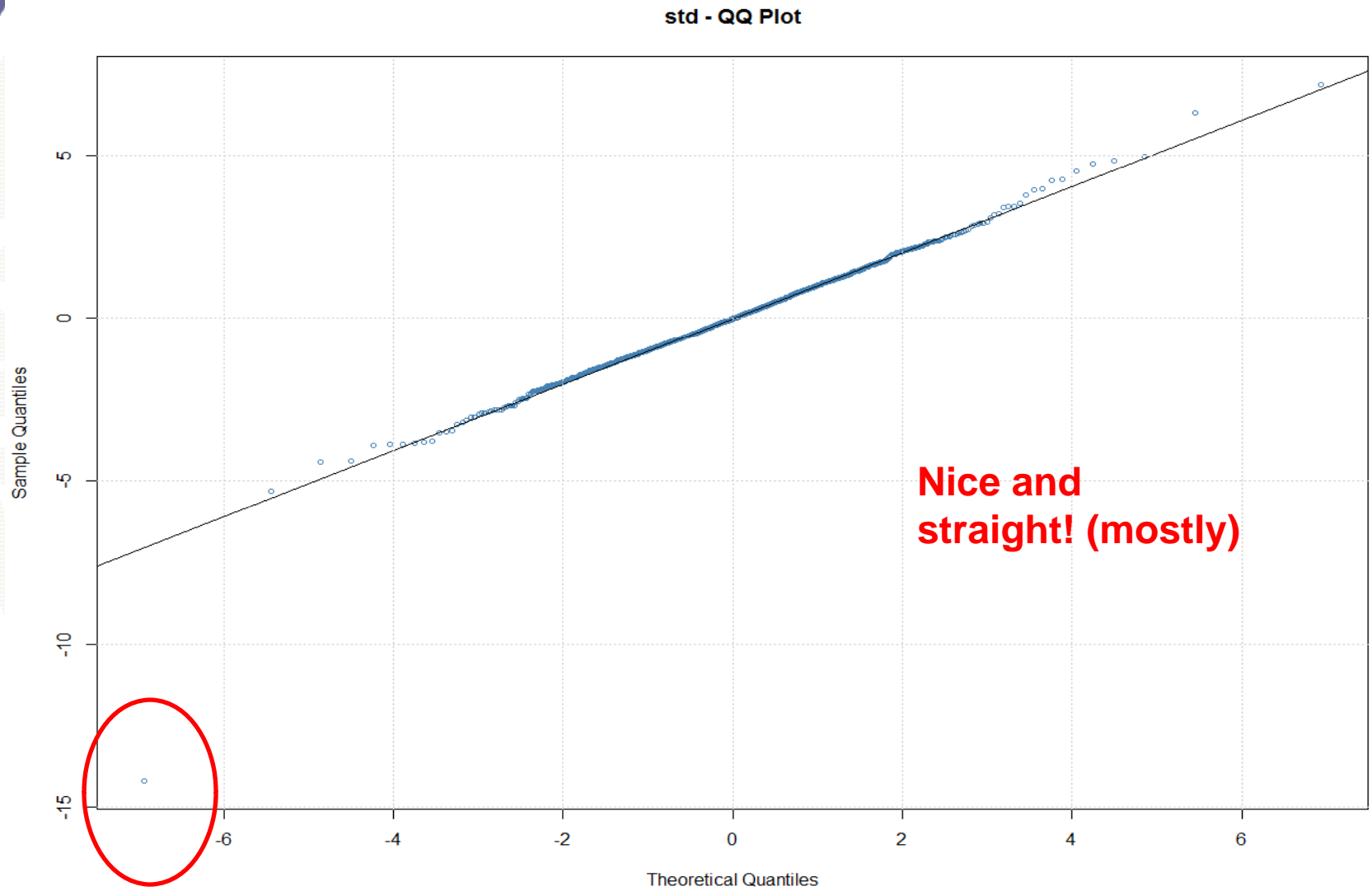
```
-----
GARCH Model      : sGARCH(1,1)
Mean Model       : ARFIMA(0,0,0)
Distribution      : std
```

Optimal Parameters

```
-----
      Estimate  Std. Error  t value  Pr(>|t|)
mu      0.000145   0.000233   0.62419  0.532502
omega   0.000002   0.000001   2.42482  0.015316
alpha1  0.062204   0.011391   5.46084  0.000000
beta1   0.936747   0.010565  88.66647  0.000000
shape   4.840443   0.403868  11.98520  0.000000
```

Estimated df = 4.84

Student-t QQ-Plot



Skew-t GARCH(1,1)

```
> garch11.st.spec = ugarchspec(variance.model = list(garchOrder=c(1,1)),
+                               mean.model = list(armaOrder=c(0,0)),
+                               distribution.model = "sstd")
> MSFT.garch11.st.fit = ugarchfit(spec=garch11.st.spec, data=MSFT.ret)
> MSFT.garch11.st.fit
```

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

Conditional Variance Dynamics

```
-----
GARCH Model      : sGARCH(1,1)
Mean Model       : ARFIMA(0,0,0)
Distribution      : sstd
```

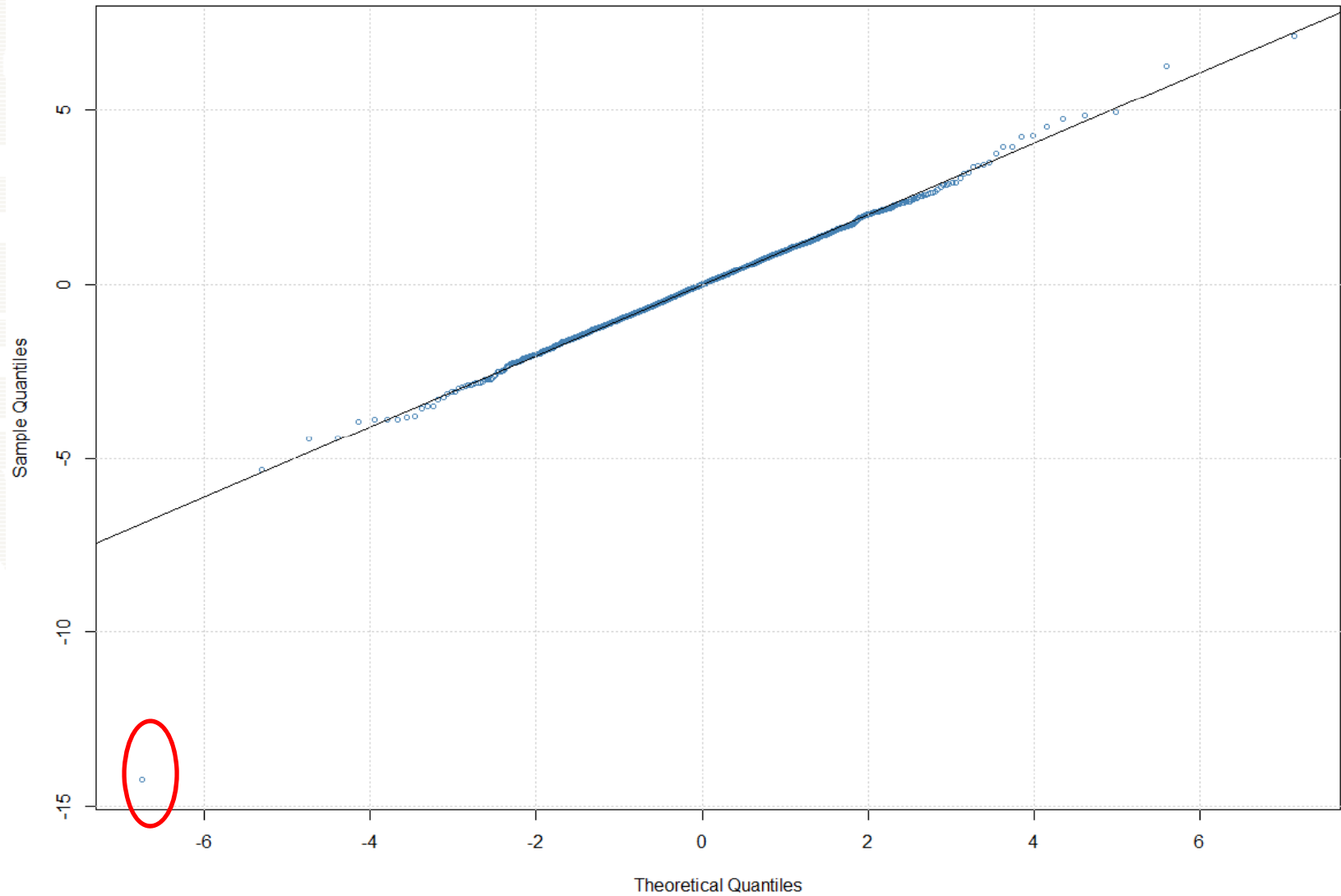
Optimal Parameters

```
-----
Estimate  Std. Error  t value  Pr(>|t|)
mu        0.000258   0.000253   1.0187  0.308332
omega     0.000002   0.000001   2.4445  0.014506
alpha1    0.062718   0.011404   5.4996  0.000000
beta1     0.936280   0.010556  88.7002  0.000000
skew      1.028568   0.025463  40.3942  0.000000
shape     4.839944   0.404462  11.9664  0.000000
```

**Estimated skew
parameter is positive!**

Skew-t QQ-Plot

sstd - QQ Plot



Forecast Comparison

Volatility Forecasts

