

# ARMA-GARCH Modeling and Forecasting

[Code ▾](#)

Casey Tirshfield

The file `sp500_d_logret.txt` contains the daily log returns on the S&P500 index from January 3, 1980 to June 28, 2007.

[Hide](#)

```
df <- read.table('sp500_d_logret.txt', header=TRUE)
# make dates column into rownames
df$Date <- as.Date(df$Date, '%m/%d/%Y')
row.names(df) <- df$Date
df[1] <- NULL
```

(a) Fit an AR(1)-GARCH(1,1) model with Gaussian innovations to the data, and give standard errors of the parameter estimates.

[Hide](#)

```
# The following code was inspired by http://www.unstarched.net/wp-content/uploads/2013/06/an-example-in-rugarch.pdf
model <- ugarchspec(variance.model=list(model='sGARCH', garchOrder=c(1, 1)), mean.model=list(armaOrder=c(1, 0), include.mean=TRUE), distribution.model='norm')
model_fit <- ugarchfit(spec=model, data=df, solver='hybrid')
print(model_fit)
```

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

Conditional Variance Dynamics

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

Optimal Parameters

```

-----
      Estimate   Std. Error    t value Pr(>|t|)
mu      0.000221    0.000043    5.093267 0.000000
arl     0.029542    0.012681    2.329619 0.019826
omega   0.000000    0.000000    0.068161 0.945657
alpha1  0.054597    0.005334   10.236316 0.000000
beta1   0.949282    0.004699  202.019216 0.000000

```

Robust Standard Errors:

```

      Estimate   Std. Error    t value Pr(>|t|)
mu      0.000221    0.000141    1.570205 0.116367
arl     0.029542    0.011214    2.634382 0.008429
omega   0.000000    0.000010    0.001382 0.998898
alpha1  0.054597    0.325673    0.167643 0.866864
beta1   0.949282    0.282723    3.357642 0.000786

```

LogLikelihood : 28599.69

Information Criteria

```

-----
Akaike      -8.2441
Bayes      -8.2392
Shibata    -8.2441
Hannan-Quinn -8.2424

```

Weighted Ljung-Box Test on Standardized Residuals

```

-----
                        statistic p-value
Lag[1]                  2.321 0.12763
Lag[2*(p+q)+(p+q)-1][2] 2.478 0.09461
Lag[4*(p+q)+(p+q)-1][5] 6.106 0.04251
d.o.f=1
H0 : No serial correlation

```

Weighted Ljung-Box Test on Standardized Squared Residuals

```

-----
                        statistic p-value
Lag[1]                  6.989 0.008202
Lag[2*(p+q)+(p+q)-1][5] 7.919 0.030868
Lag[4*(p+q)+(p+q)-1][9] 8.572 0.099306
d.o.f=2

```

Weighted ARCH LM Tests

```

-----
      Statistic Shape Scale P-Value
ARCH Lag[3]    0.7230 0.500 2.000 0.3952
ARCH Lag[5]    0.7591 1.440 1.667 0.8055
ARCH Lag[7]    1.2087 2.315 1.543 0.8774

```

```
Nyblom stability test
```

```
-----  
Joint Statistic:  2043.62
```

```
Individual Statistics:
```

```
mu          0.05342
```

```
arl         1.52744
```

```
omega 693.64476
```

```
alpha1  0.08163
```

```
beta1    0.03841
```

```
Asymptotic Critical Values (10% 5% 1%)
```

```
Joint Statistic:          1.28 1.47 1.88
```

```
Individual Statistic:    0.35 0.47 0.75
```

```
Sign Bias Test
```

```
-----  
                t-value      prob sig  
Sign Bias          0.9221 3.565e-01  
Negative Sign Bias  4.6694 3.078e-06 ***  
Positive Sign Bias  2.5799 9.903e-03 ***  
Joint Effect       41.0850 6.273e-09 ***
```

```
Adjusted Pearson Goodness-of-Fit Test:
```

```
-----  
  group statistic p-value(g-1)  
1    20      147.8   5.817e-22  
2    30      169.1   1.014e-21  
3    40      192.2   3.944e-22  
4    50      191.6   9.399e-19
```

```
Elapsed time : 1.038122
```

**(b) Compute  $k$ -days-ahead forecasts ( $k = 1, \dots, 5$ ) of the log returns and its volatility, using the fitted model and June 28, 2007 as the forecast origin.**

Hide

```
model_forecast <- ugarchforecast(model_fit, data = NULL, n.ahead = 5, n.roll= 0, out.  
sample = 0)  
print(model_forecast)
```

```
*-----*
*          GARCH Model Forecast          *
*-----*
```

Model: sGARCH  
Horizon: 5  
Roll Steps: 0  
Out of Sample: 0

0-roll forecast [T0=2007-06-28]:

	Series	Sigma
T+1	0.0001941	0.003403
T+2	0.0002200	0.003411
T+3	0.0002207	0.003420
T+4	0.0002208	0.003428
T+5	0.0002208	0.003437