

# Hybrid Arima-sGARCH

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# Data import

```
# Import Data  
sp <- getSymbols(Symbols = "^GSPC", from = "2000-01-01",  
                 to = "2021-12-13", src = "yahoo",  
                 adjust=TRUE, auto.assign = FALSE)  
sp_prices <- Ad(sp)  
head(sp_prices)
```

GSPC.Adjusted

2000-01-03	1455.22
2000-01-04	1399.42
2000-01-05	1402.11
2000-01-06	1403.45
2000-01-07	1441.47
2000-01-10	1457.60

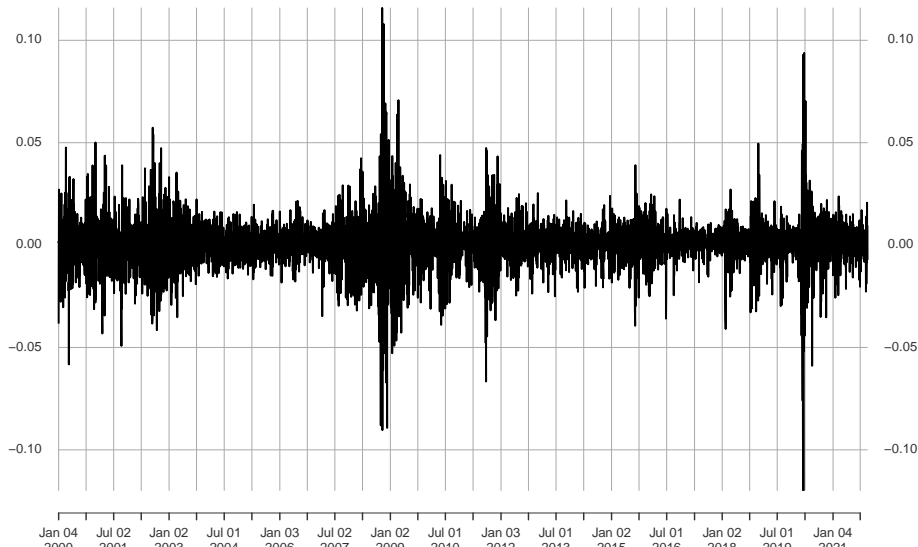
# Return calculation

```
#Compute the log returns  
returns <- CalculateReturns(sp_prices) %>% na.omit()  
data <- returns
```

# Return calculation

returns

2000-01-04 / 2021-12-10



## 'rugarch' package exploration

- **ugarchspec()**: Method for creating a univariate GARCH specification object prior to fitting.
- **ugarchfit()**: Method for fitting a variety of univariate GARCH models.
- **ugarchroll()**: Method for creating rolling density forecast from ARMA-GARCH models with option for refitting every n periods with parallel functionality.
- **ugarchboot()**: Method for forecasting the GARCH density based on a bootstrap procedures (see details and references).
- **ugarchforecast()**: Method for forecasting from a variety of univariate GARCH models.
- **ugarchfilter()**: Method for filtering a variety of univariate GARCH models.
- **ugarchpath()**: Method for simulating the path of a GARCH model from a variety of univariate GARCH models.

## Specify sGarch model

```
# Specify sGARCH model
spec <- ugarchspec(
  variance.model =
    list(model = "sGARCH",
          garchOrder = c(1,1)),
  mean.model =
    list(armaOrder = c(0,0),
          include.mean = TRUE),
  distribution.model = "ged"
)
```

We choose the best model from the paper and reproduce it. The best model is hybrid model ARIMA(p,1,q)-SGARCH(1,1) with GED distribution (SGARCH.GED 1000), so we define the model = "sGARCH" and define the distribution model as ged.

# Fit Arima-sGARCH Model

```
# Fit to the data  
data -> y  
  
sGARCH <- ugarchfit(spec = spec,  
                    data = y,  
                    solver = 'hybrid')
```

The solver parameter accepts a string stating which numerical optimizer to use to find the parameter estimates. The “hybrid” strategy solver first tries the “solnp” solver, in failing to converge then tries then “nlnminb”, the “gosolnp” and finally the “nloptr” solvers. The out.sample option is provided in order to carry out forecast performance testing against actual data.



# Fit Arima-sGARCH Model

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

## Conditional Variance Dynamics

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

## Optimal Parameters

```
-----
      Estimate  Std. Error  t value  Pr(>|t|)
mu      0.000741    0.000089   8.3242  0.000000
omega    0.000002    0.000001   1.6829  0.092397
```

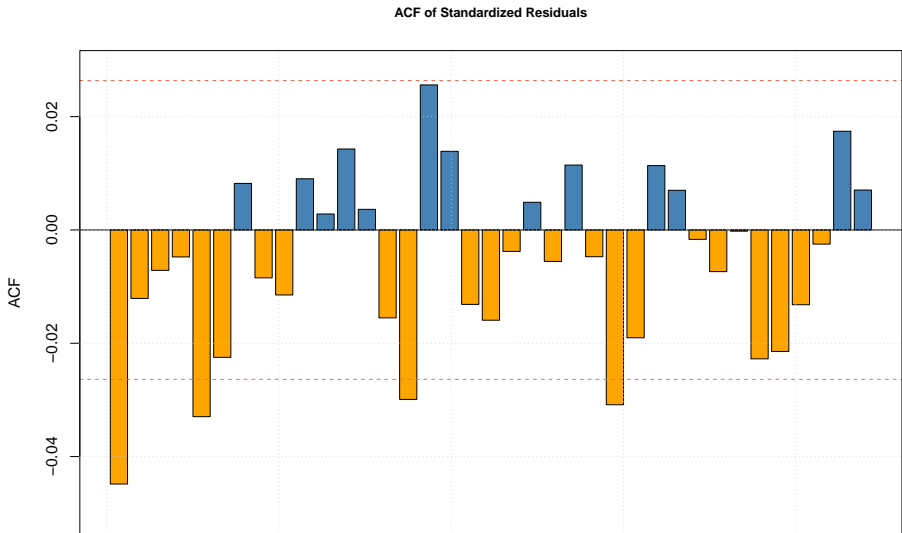
# Fit Arima-sGARCH Model

```
# Results information criteria  
infocriteria(sGARCH)
```

Akaike	-6.518885
Bayes	-6.512893
Shibata	-6.518886
Hannan-Quinn	-6.516795

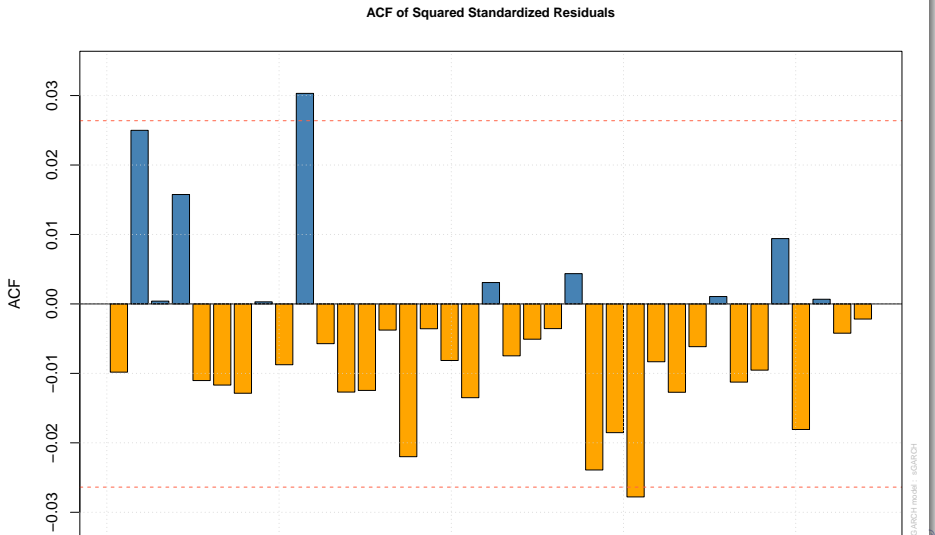
# Residual Diagnostic

## Standardized residual ACF



# Residual Diagnostic

## Standardized Squared residuals ACF



# Forecast for fitted model

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

Model: sGARCH

Horizon: 5

Roll Steps: 0

Out of Sample: 0

0-roll forecast [T0=2021-12-10]:

	Series	Sigma
T+1	0.0007408	0.01151
T+2	0.0007408	0.01153
T+3	0.0007408	0.01155
T+4	0.0007408	0.01158
T+5	0.0007408	0.01160

## Rolling Forecast for window size 1000

```
roll <- ugarchroll(spec = spec,  
                  data = data,  
                  n.ahead = 1,  
                  n.start = 3000,  
                  refit.every = 50,  
                  refit.window = "moving",  
                  solver = "hybrid",  
                  window.size = 1000,  
                  keep.coef = TRUE)
```

Refit in moving window where all previous data is used for the first estimation and then moved by a length equal to refit.every

# Rolling Forecast for window size 1000

```
*-----*
*                GARCH Roll                *
*-----*
```

```
No.Refits      : 51
Refit Horizon   : 50
No.Forecasts    : 2521
GARCH Model     : sGARCH(1,1)
Distribution     : ged
```

Forecast Density:

	Mu	Sigma	Skew	Shape	Shape(GIG)	Realized
2011-12-06	9e-04	0.0185	0	1.303	0	0.0011
2011-12-07	9e-04	0.0175	0	1.303	0	0.0020
2011-12-08	9e-04	0.0165	0	1.303	0	-0.0211
2011-12-09	9e-04	0.0173	0	1.303	0	0.0169

# Rolling Forecast for window size 1000

## refit.window

Refit in moving window where all previous data is used for the first estimation and then moved by a length equal to refit.every. Another refit window is “recursive”, which expand the window size including all the previous data.



# Error Metrics

```
rugarch::report(roll, type = "fpm")
```

GARCH Roll Mean Forecast Performance Measures

-----  
Model : sGARCH  
No.Refits : 51  
No.Forecasts: 2521

Stats

MSE 0.0001065  
MAE 0.0065320  
DAC 0.5518000