```
* Dr. Steven S. Vickner;
* MSBA 635 - Data Analytics II;
* print data;
```

Autoregressive Conditional Heteroskedasticity (ARCH) models are heavily used in forecasting where the time series variance of the errors is not constant due to periods of volatility in the underlying time series • Generalized Autoregressive Conditional Heteroskedasticity (GARCH) models are ARCH models that also capture the effects of lagged, non-constant time series variance of the errors

```
*try to explain the variability and monthly stock returns
*NOT ON HW OR ON TEST
proc print data=tmp1.byd (obs=10);
run;
```

```
  The SAS System         17:32 Tuesday, January 22, 2019   1

                                        Obs        r

                                          1     0.00000
                                          2    -0.22719
                                          3     1.35084
                                          4     1.10556
                                          5     0.06550
                                          6     1.68119
                                          7     1.05137
                                          8     0.48193
                                          9     1.10711
                                         10     0.67096
```

```
* display data attributes;
*returns to share of the stock brighten your day
proc contents data=tmp1.byd;
run;
```

```
The SAS System         17:32 Tuesday, January 22, 2019   2

                                The CONTENTS Procedure

            Data Set Name        TMP1.BYD                      Observations          500
            Member Type          DATA                          Variables             1
            Engine               V9                            Indexes               0
            Created              08/07/2010 13:33:20           Observation Length    8
            Last Modified        08/07/2010 13:33:20           Deleted Observations  0
            Protection                                         Compressed            NO
            Data Set Type                                      Sorted                NO
            Label
            Data Representation  WINDOWS_32
            Encoding             wlatin1  Western (Windows)


                                Engine/Host Dependent Information

                 Data Set Page Size          4096
                 Number of Data Set Pages    2
                 First Data Page             1
                 Max Obs per Page            501
                 Obs in First Data Page      364
                 Number of Data Set Repairs  0
                 Filename                    C:\Users\nxnguy01\Desktop\byd.sas7bdat
                 Release Created             9.0202M0
                 Host Created                XP_PRO


                            Alphabetic List of Variables and Attributes

        #    Variable    Type    Len    Label

        1    r           Num       8    returns to shares in BrightenYourDay (BYD) Lighting
```

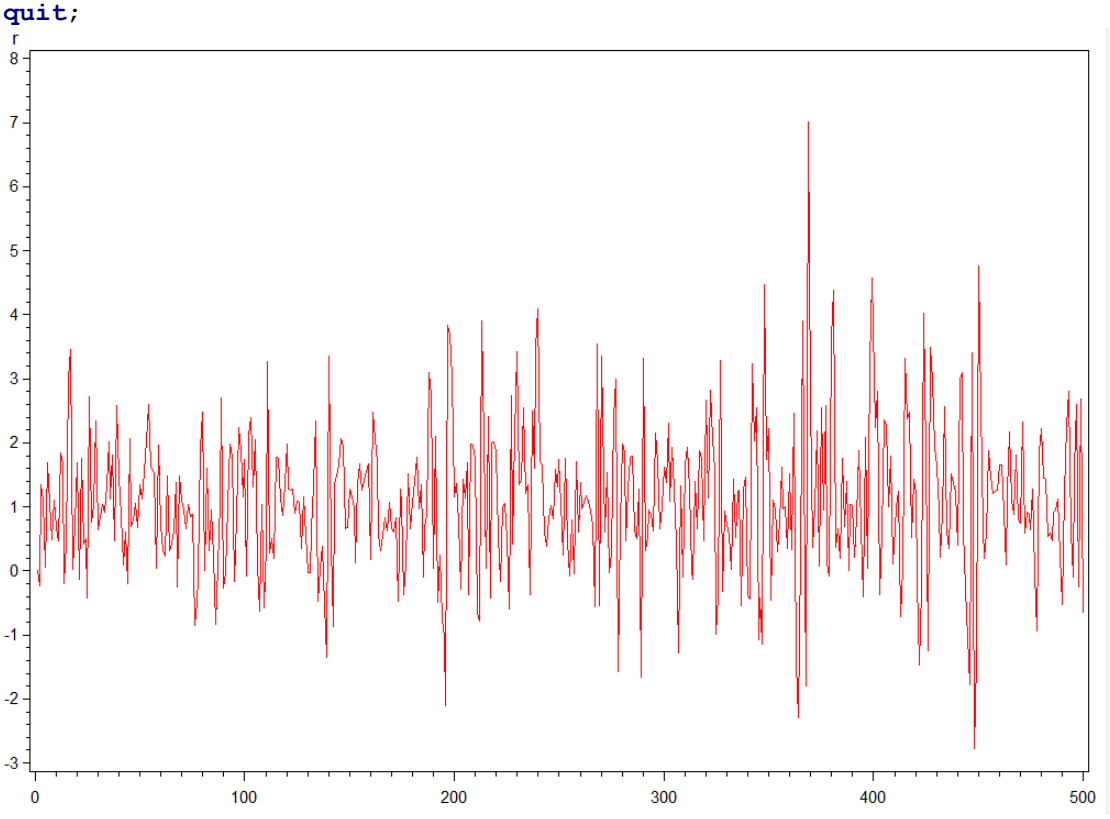
```
* construct new variables;
*time to run from 1-500 set it up with the notation _n_ meaning you increment up by 1 in
your dataset
data byddata;
set tmp1.byd;
time = _n_;
run;

* print data;
*for 10 observations

proc print data=work.byddata (obs=10);
run;
```


Obs	r	time
1	0.00000	1
2	-0.22719	2
3	1.35084	3
4	1.10556	4
5	0.06550	5
6	1.68119	6
7	1.05137	7
8	0.48193	8
9	1.10711	9
10	0.67096	10

```
* plot data;
*this is stationary, the variability looks similar. There is one point where theres
volatility
options nolabel;
symbol1 value=none interpol=join color=red;
proc gplot data=work.byddata;
plot r*time;
run;
quit;
```



```
* estimate arch model using proc autoreg;
*right-hand side equals nothing
*create a forecast of volatility using 'ht'
*you are rejecting the null that you don't have volatility
*you in fact do have volatility
*average return is 0.8%
options nolabel;
proc autoreg data=work.byddata;
model r = / method=ml archtest garch=(q=1);
output out=bydout r=ehat_arch ht=harch;
run;
quit;
```


The AUTOREG Procedure

Dependent Variable r

Ordinary Least Squares Estimates

SSE	700.737278	DFE	499
MSE	1.40428	Root MSE	1.18502
SBC	1593.91561	AIC	1589.701
MAE	0.89611155	AICC	1589.70903
MAPE	472.633376	HQC	1591.35481
Durbin-Watson	1.9190	Total R-Square	0.0000

Tests for ARCH Disturbances Based on OLS Residuals

Order	Q	Pr > Q	LM	Pr > LM
1	62.6104	<.0001	62.2819	<.0001
2	84.4581	<.0001	66.2737	<.0001
3	97.7368	<.0001	68.5130	<.0001
4	100.3119	<.0001	68.7221	<.0001
5	105.0300	<.0001	70.4004	<.0001
6	106.0590	<.0001	70.5316	<.0001
7	106.4676	<.0001	72.2938	<.0001
8	107.6972	<.0001	73.0515	<.0001
9	109.6069	<.0001	73.3493	<.0001
10	111.5931	<.0001	73.5252	<.0001
11	111.7335	<.0001	73.9982	<.0001
12	111.9903	<.0001	75.1742	<.0001

Parameter Estimates

Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
Intercept	1	1.0783	0.0530	20.35	<.0001

Algorithm converged.

GARCH Estimates

SSE	700.840315	Observations	500
MSE	1.40168	Uncond Var	1.49106919
Log Likelihood	-740.79331	Total R-Square	.

SBC	1500.23044	AIC	1487.58661
MAE	0.89555713	AICC	1487.635
MAPE	466.72465	HQC	1492.54803
		Normality Test	0.2817
		Pr > ChiSq	0.8686

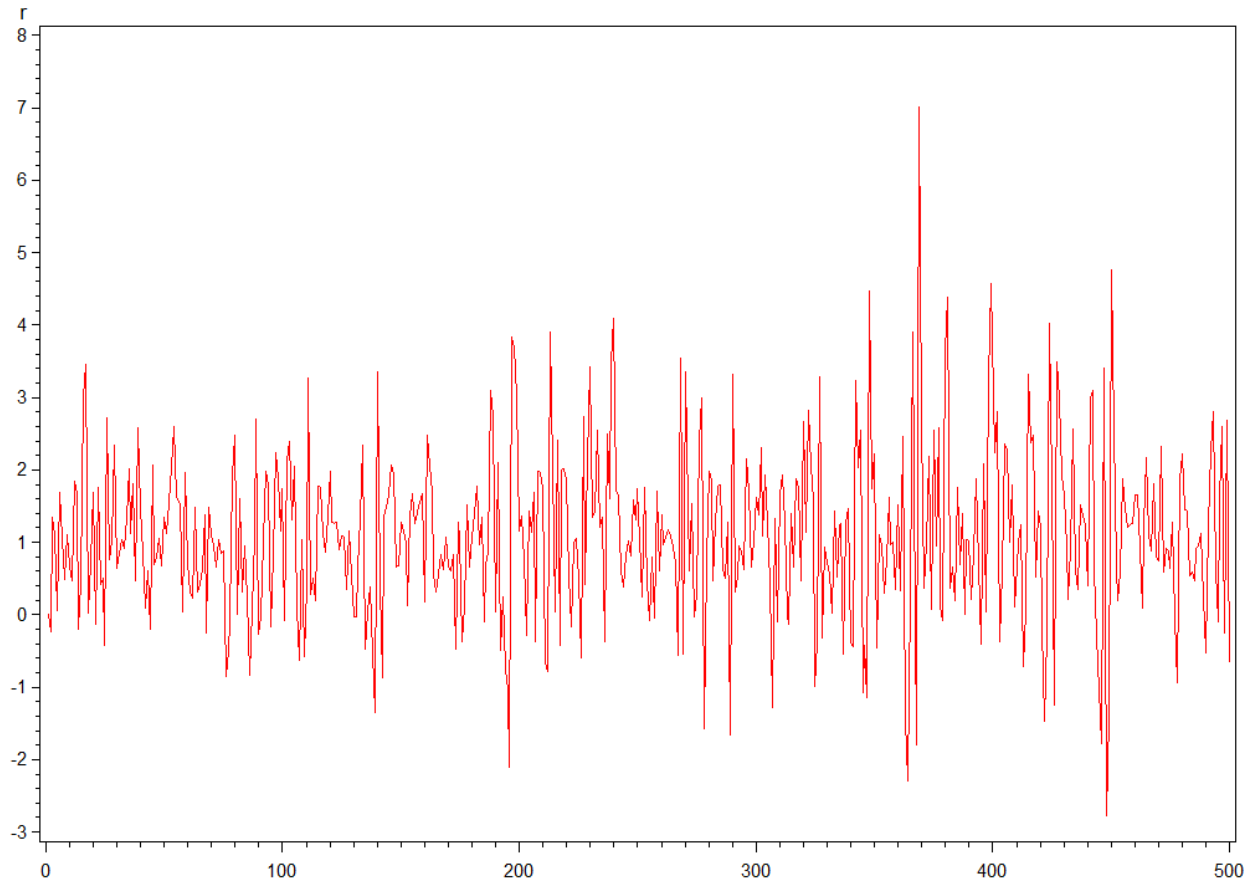
*this is the model of conditional volatility
*it is highly significantly significant

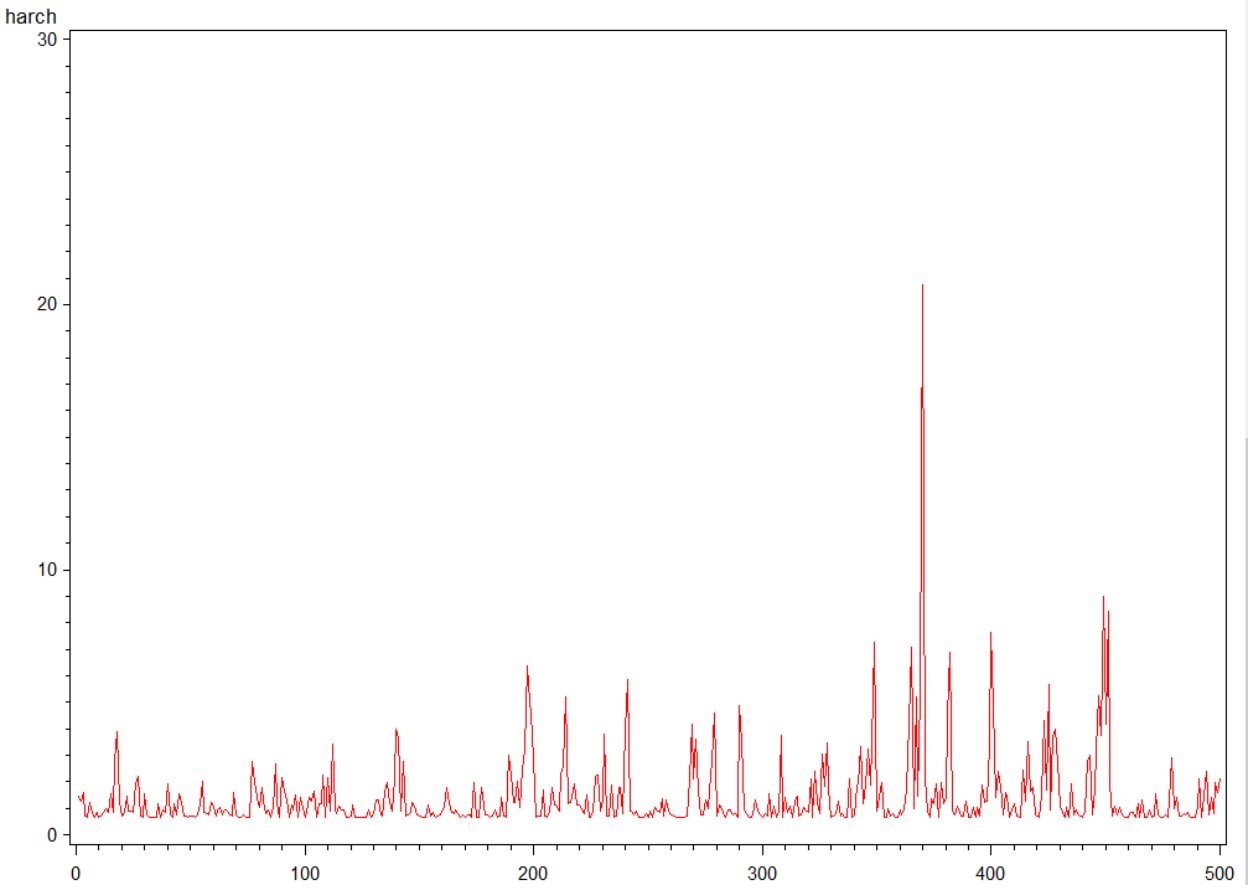
The AUTOREG Procedure

Parameter Estimates

Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
Intercept	1	1.0639	0.0396	26.89	<.0001
ARCH0	1	0.6421	0.0634	10.13	<.0001
ARCH1	1	0.5693	0.1032	5.52	<.0001

```
* plot data;
*graph 2 is a model of conditional volatility
*conditional returns is where they group
options nolabel;
symbol1 value=none interpol=join color=red;
proc gplot data=work.bydout;
plot harch*time;
run;
quit;
```






```
* estimate garch model using proc autoreg;
*this is plot of future volatility
options nolabel;
proc autoreg data=work.byddata;
model r = / method=ml archtest garch=(p=1,q=1);
output out=bydout2 r=ehat_garch ht=hgarch;
run;
quit;
```


The AUTOREG Procedure

Dependent Variable r

Ordinary Least Squares Estimates

SSE	700.737278	DFE	499
MSE	1.40428	Root MSE	1.18502
SBC	1593.91561	AIC	1589.701
MAE	0.89611155	AICC	1589.70903
MAPE	472.633376	HQC	1591.35481
Durbin-Watson	1.9190	Total R-Square	0.0000

Tests for ARCH Disturbances Based on OLS Residuals

Order	Q	Pr > Q	LM	Pr > LM
1	62.6104	<.0001	62.2819	<.0001
2	84.4581	<.0001	66.2737	<.0001
3	97.7368	<.0001	68.5130	<.0001
4	100.3119	<.0001	68.7221	<.0001
5	105.0300	<.0001	70.4004	<.0001

6	106.0590	<.0001	70.5316	<.0001
7	106.4676	<.0001	72.2938	<.0001
8	107.6972	<.0001	73.0515	<.0001
9	109.6069	<.0001	73.3493	<.0001
10	111.5931	<.0001	73.5252	<.0001
11	111.7335	<.0001	73.9982	<.0001
12	111.9903	<.0001	75.1742	<.0001

Parameter Estimates

Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
Intercept	1	1.0783	0.0530	20.35	<.0001

Algorithm converged.

GARCH Estimates

SSE	701.141027	Observations	500
MSE	1.40228	Uncond Var	1.47930255
Log Likelihood	-736.02876	Total R-Square	.
SBC	1496.91594	AIC	1480.05751
MAE	0.89519324	AICC	1480.13832
MAPE	460.953781	HQC	1486.67273
		Normality Test	0.9803
		Pr > ChiSq	0.6125

The AUTOREG Procedure

Parameter Estimates

Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
Intercept	1	1.0499	0.0406	25.84	<.0001
ARCH0	1	0.4011	0.0903	4.44	<.0001
ARCH1	1	0.4909	0.1019	4.82	<.0001
GARCH1	1	0.2380	0.1119	2.13	0.0335

```
* plot data;

options nolabel;
symbol1 value=none interpol=join color=red;
proc gplot data=work.bydout2;
plot hgarch*time;
run;
quit;
```