Model development log

```
#use 30 years quarterly -- Quarterly  Jan 1983 -Dec 2012]
#read in data as "qdata"
require(forecast)
require(lmtest)
require(tseries)

# Goldfeld-Quandt test for homoscedasticity
gqtest(qdata~1)
```

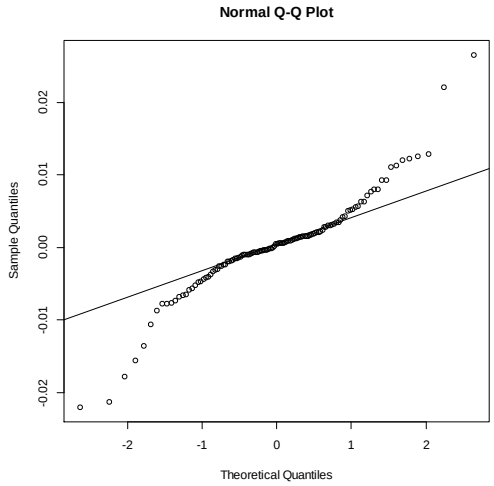
```
        Goldfeld-Quandt test

data:  qdata ~ 1
GQ = 6.7475, df1 = 59, df2 = 59, p-value = 3.959e-12
```

```
# choose to log transform the data
lq = log(qdata)
adf.test(lq)
```

```
        Augmented Dickey-Fuller Test

data:  lq
Dickey-Fuller = -3.9467, Lag order = 4, p-value =
0.01422
alternative hypothesis: stationary
```

```
# auto.arima runs an automatic selection process by minimizing AIC/BIC/AICC
naic.model = auto.arima(lq, test= “adf”)

                Series: lq
                ARIMA(2,0,0) with non-zero mean

                Coefficients:
                         ar1      ar2  intercept
                      1.9316  -0.9323     4.9658
                s.e.  0.0536   0.0542     2.5143

                sigma^2 estimated as 4.625e-05:  log likelihood=429.86
                AIC=-851.71   AICc=-851.36   BIC=-840.56

shapiro.test(naic.model$residuals) # test for standard normality of residuals

                Shapiro-Wilk normality test
                data:  naic.model.16$residuals
                W = 0.91935, p-value = 2.207e-06
```

```
qqnorm(naic.model$residuals); qqline(naic.mode1$residuals) # graphical test for normality
```




```
#because of residual fat tails, can't simulate using standard normal errors - choose model by resampling centered residuals.

#to run simulation need to load the provided function "naic.arima.3"

sim.100k.b4 = naic.arima.3(naic.model, 100000, 240,4) #1000 paths, 80 periods per path and blocks of 4 residuals


# can calculate various percentiles by

perc = seq(.01,.99,.01)

matrix = matrix(nrow=99,ncol=81)

for (i in 1:99) { matrix[i,]= apply(sim.100k.b4, 2,quantile, perc[i], type = 8)}


# export file

write.csv(sim.100k.b4,file="sim.csv")
```