

Question 3.41

I first plot data and diff(data). The diff(data) looks to exhibit more stationary trends.

I then plot the ACF and PACF using the acf2 function.

There is a clear seasonality trend every 12 months or 1 year. The diff suggests an ARIMA d

of 1 and s of 12 to capture this seasonal trend. The ACF seems to tail off, and PACF

looks to maybe cut off after 1 large lag, or 2. I first tried an ARIMA(1,1,0) x (0,1,0)₁₂ as

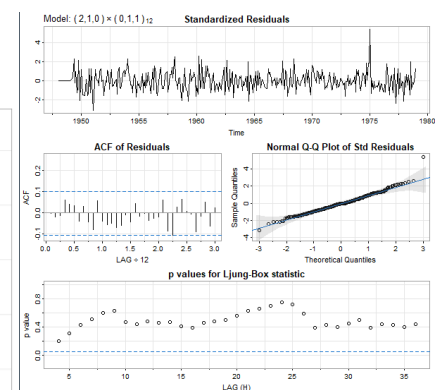
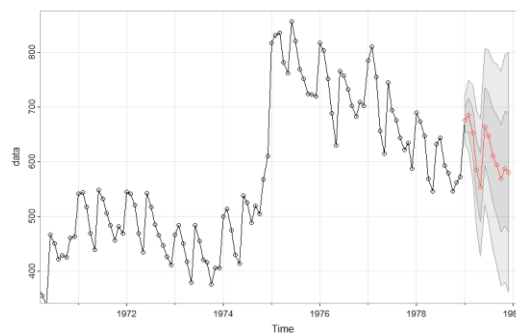
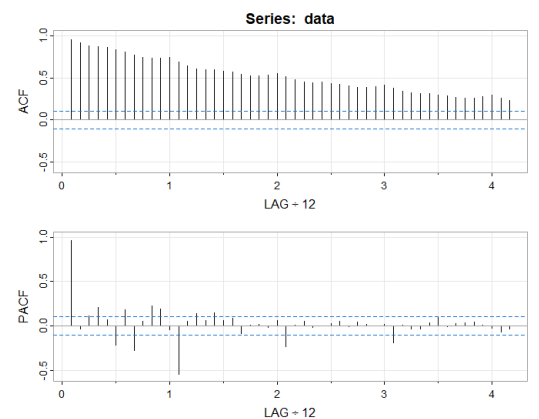
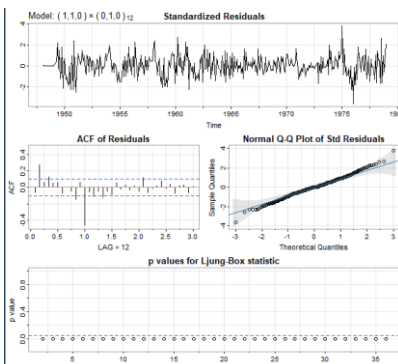
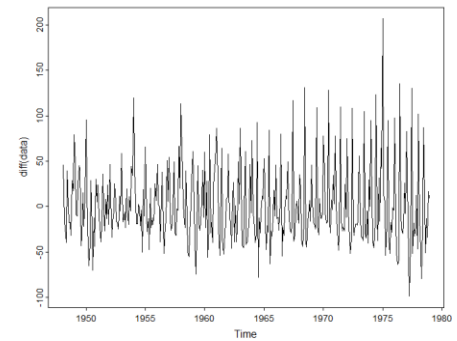
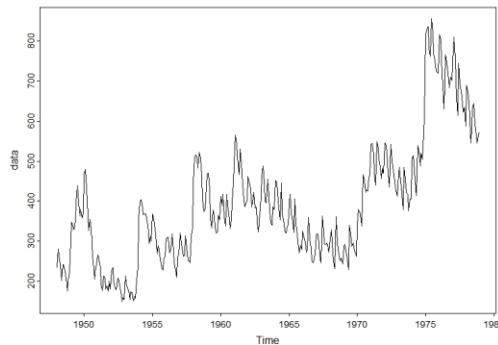
an initial guess. Here are the results: The QQ plot looks decent, but the p values for

the box test do not give me much hope. I decided to bump up the AR value to capture this significant lag in PACF. This new ARIMA(2,1,0) x

(0,1,1)₁₂ worked much much better. For fun I ran an auto

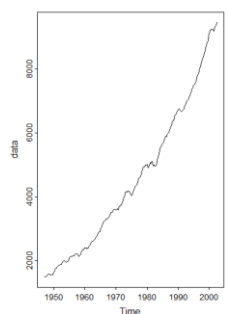
arma function too. It gave me

a model. Forecast looks decent too!



Question 5.4

After plotting the data, yea the graph definitely looks explosive. I ran the 3 tests from the supplemental reading, all with the alternative hypothesis = “explosive”. Each of them gave a p-value of .01, meaning we reject the null in favor of the alternative, being that according to each of these 3 tests the series is explosive.



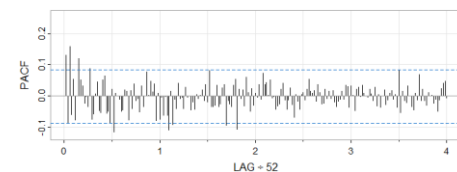
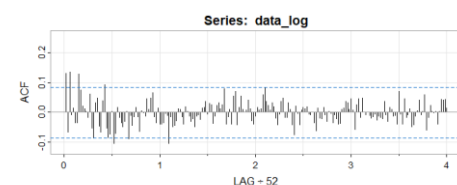
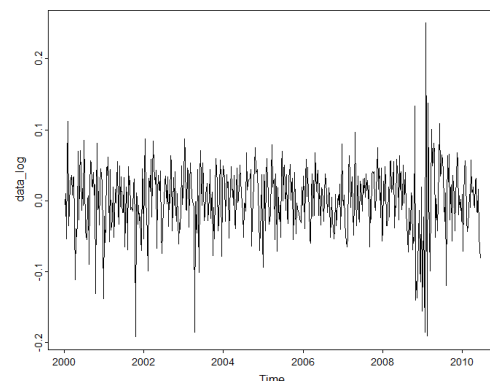
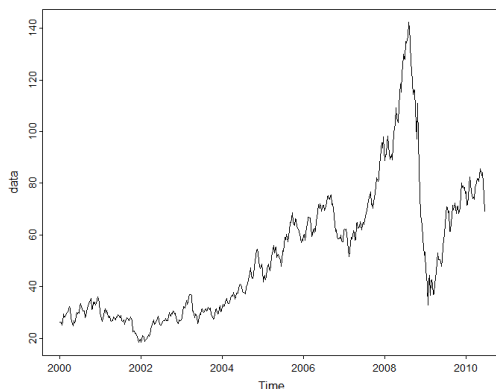
Question 5.6

First I plotted the data and the $\text{diff}(\log(\text{data}))$. The log data looks like much more of an appropriate fit for a GARCH model. I tried a bunch of different SARIMA models to see

what the general trends looked like. The ACF and PACF of the $\text{diff}(\log(\text{data}))$ were both not very helpful, as many of the lag coefficients were non-significant. I settled on this model:

It's not perfect, the Q-Q plot looks decent until about the ± 2 std dev from 0. Many of the p-values for the box test are close to the line for a significant p-value, but the first few start out pretty great. I ran a GARCH model as such, following the book's code and some online suggestions for basic GARCH models. The results are shown below in black. Many of the p values are very low, which indicate a model that fits well.

Overall it's not the best model in the world, but it seems to perform pretty well.



```
gmodel = garchFit(~arma(2,1) + garch(1,0), data_log)
```

Standardised Residuals Tests:

			Statistic	p-value
Jarque-Bera Test	R	Chi^2	124.4050971	0.000000e+00
Shapiro-wilk Test	R	W	0.9676387	1.387584e-09
Ljung-Box Test	R	Q(10)	13.7927856	1.826548e-01
Ljung-Box Test	R	Q(15)	18.6345369	2.307750e-01
Ljung-Box Test	R	Q(20)	24.7018406	2.130768e-01
Ljung-Box Test	RA2	Q(10)	96.3419940	3.330669e-16
Ljung-Box Test	RA2	Q(15)	110.2326694	1.110223e-16
Ljung-Box Test	RA2	Q(20)	115.8653749	1.665335e-15
LM Arch Test	R	TRA2	62.9511081	6.505934e-09

Information Criterion Statistics:

AIC	BIC	SIC	HQIC
-3.359849	-3.312434	-3.360089	-3.341311

