

# Homework 8

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Registered S3 method overwritten by 'quantmod':

```
method          from  
as.zoo.data.frame zoo
```

Attaching package: 'astsa'

The following object is masked from 'package:forecast':

gas

1a)

Steps For HW seasonal data 1. Examine a graph of the data, determine is an additive or multiplicative season effect in the more appropriate 2. Provide starting values for  $L_1$  and  $T_1$  as well as season values for the first year  $I_1, I_2, \dots, I_s$  3. Estimate values for  $\alpha, \gamma, \delta$  by minimizing  $\sum e_t^2$  4. decide whether to normalize the season indices at regular intervals by maken them sum to zEro in the additive case or have an average of one in the multiplicative case. 5. Choose between a fully automatic approach, and a non-automatic approach.

Decisions to be made for 2 parameter HW is choice of smoothing parameters  $\alpha, \gamma$ . For HW with seasonaility and trend we need to estimate the values of three quantities and choose the values of three paramters  $L_t, T_t, I_t$  and  $\alpha, \gamma, \delta$  respectively. AS well as seasonal values for a time period such as the first year,  $I_1, I_2, \dots, I_s$

1b) We need to provide starting values  $T_1, L_1$  and values for a time period such as the first year  $I_1, I_2, \dots, I_s$ . For the two parameter version there are no starting values to provide, one just needs to make a choice of smoothing parameters  $\alpha, \gamma$

1c) Parameters that need to be estimated for three parameter model  $\alpha, \gamma, \delta$  for the two parameter model  $\alpha, \gamma$ . All of these are taking  $\in (0, 1)$

1d) There are 2 values that can be provided to the argument intial (“optimal”, “simple”).

If optimal is used the initial values are optimized along with the smoothing parameters using ets. the ets function restricts seasonality to be a maximum period of 24, to allow hourly data but not data with a larger seasonal frequency.

If simple is used the initial values are set to values obtained using simple calculations on the first few observations.

2) Consider the Johnson and Johnson quarterly return data.

```
data(jj)
```

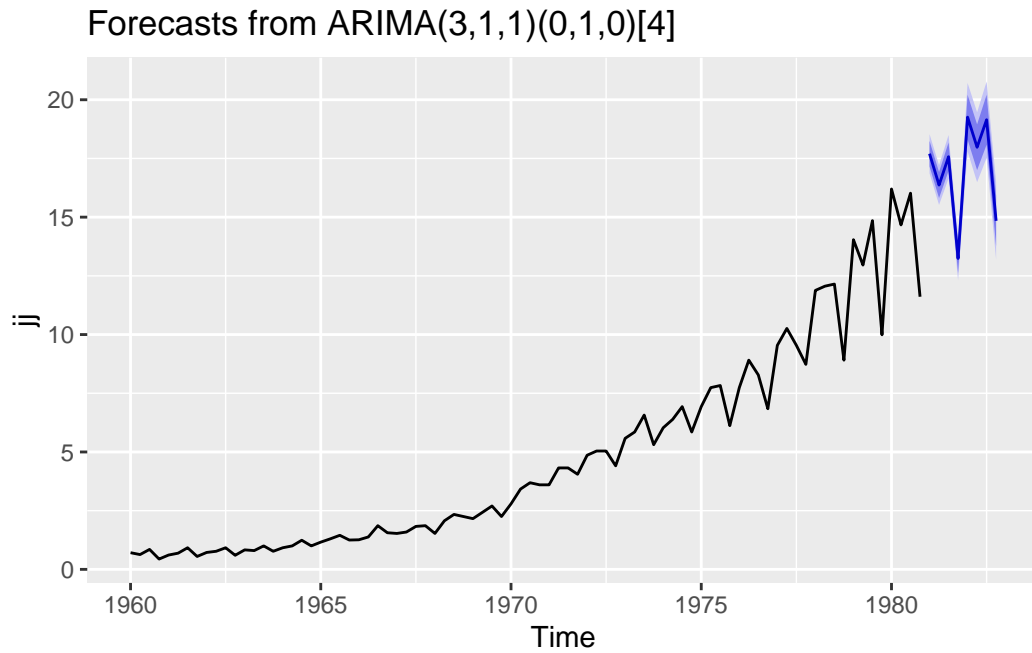
a) Fit a seasonal ARIMA model to the Johnson and Johnson quarterly return data, and forecast (including prediction intervals) the next 8 quarters

```
fit_jj <- auto.arima(jj)
```

We can see the auto.arima() function has chosen a model that conforms to the specifications in the question. a SARIMA(3,1,1)(0,1,0)<sub>4</sub> model has been chosen with coefficients  $ar1 = -.1712$ ,  $ar2 = .1387$ ,  $ar3 = -.208$ , and  $ma1 = -.6636$ .

```
# prediction for next 8 quarters  
pred <- forecast(fit_jj, h = 8)
```

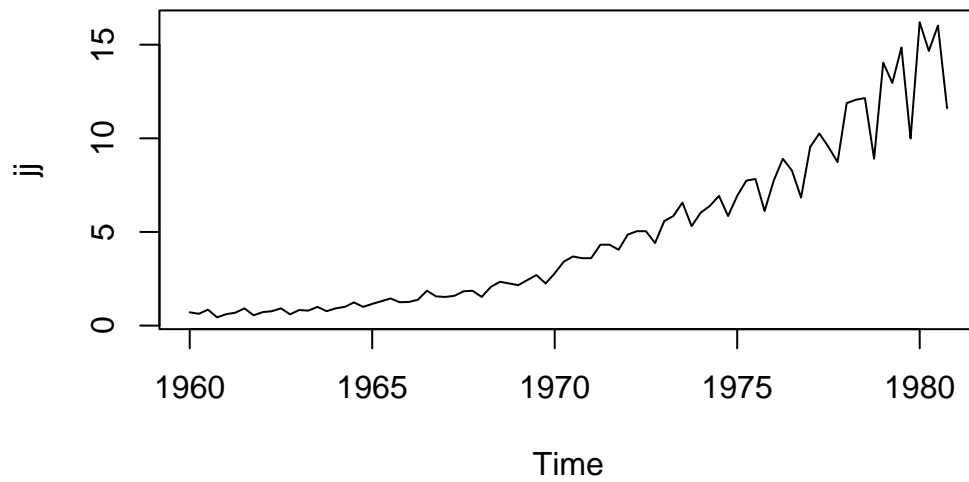
```
autoplot(pred)
```



- b) Use `hw()` function to produce forecasts (including prediction intervals) for `jj` data for the next 8 quarters.

First we should determine if we think a multiplicative model or an additive model would be the best fit for this data.

```
plot(jj)
```

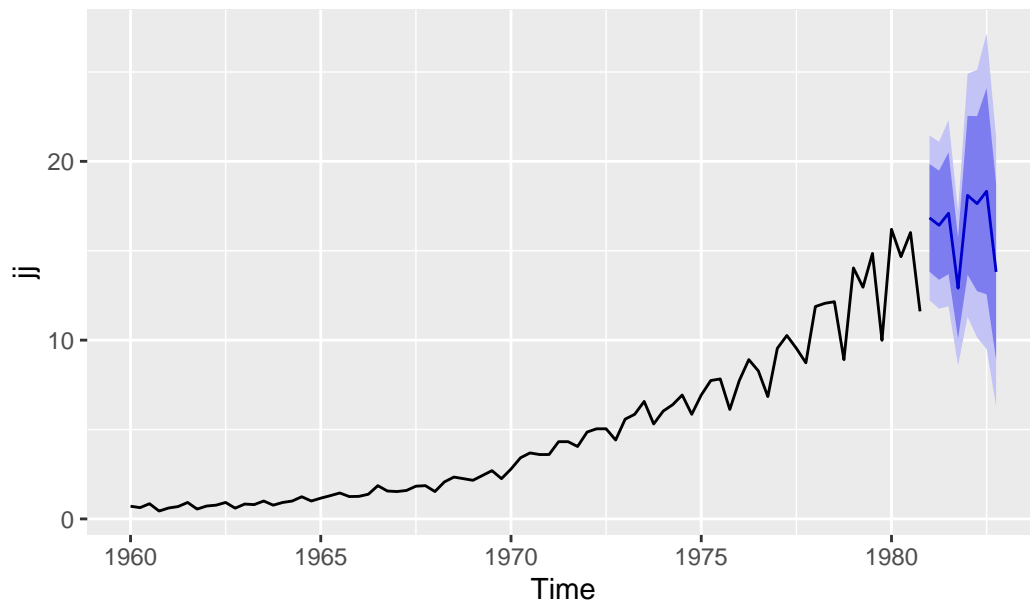


We can see from the plot that a multiplicative model may be best for our data as the variance is increasing over time.

```
hw_jj <- hw(jj, seasonal = c("multiplicative"), h = 8)
```

```
autoplot(hw_jj)
```

### Forecasts from Holt–Winters' multiplicative method

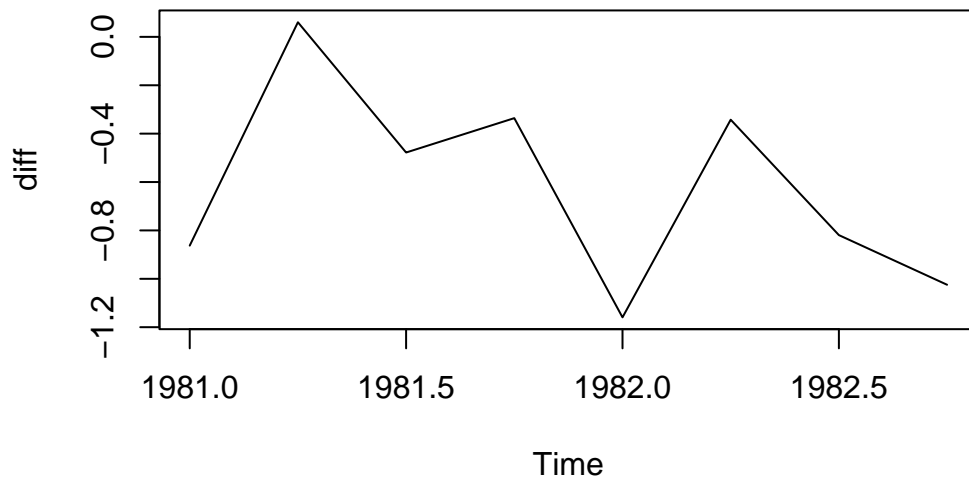


- c) Based on the forecasts obtained in a, and b. compare these two different forecasting procedures.

We can see from the forecasts above that the SARIMA model forecasts data that has a much smaller prediction interval for the error, and that the HW model has a much larger PI. This isn't indicative that one model may be a better fit over the other however. We can look at the difference of approximations between the models

```
diff <- hw_jj$mean - pred$mean
```

```
plot(diff)
```



We can see from the difference of the two series that for the most part the HW estimation was more conservative and estimated lower values than the SARIMA model.

With the ease of function in the forecast package the procedures for obtaining forecasts with the holt-winters method and a SARIMA method are both pretty straight forward and easy. If we were to go with a more manual approach to fitting a SARIMA model it would take much longer and require much more investigation to produce a model and forecasts.

Overall the two models are pretty comparable and it would be up to the analyst to decide which they would choose to go with, and stay true to there decision.