Group 8 presentation

Stat 443 Forecasting
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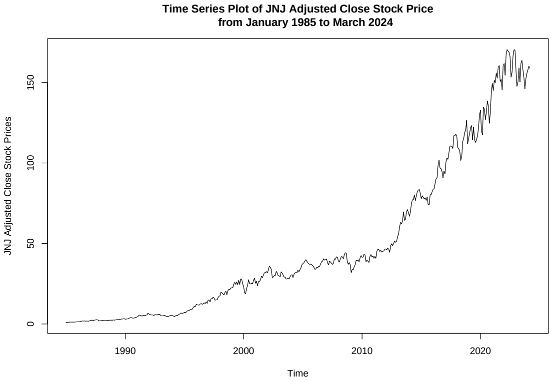
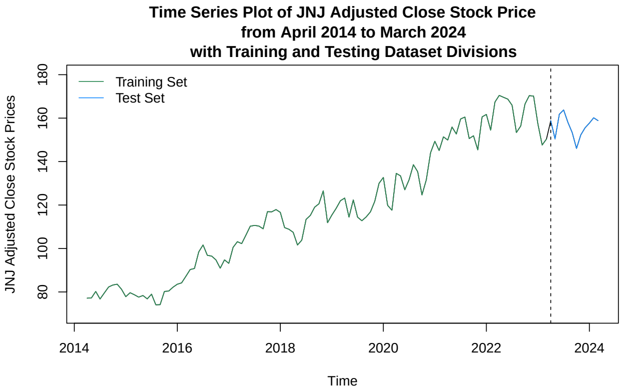
Data Description

Table 1: First Five Rows of JNJ Historical Stock Prices

Date	Open	High	Low	Close	Adj.Close
1985-01-01	2.242188	2.453125	2.195313	2.437500	0.975024
1985-02-01	2.390625	2.507813	2.312500	2.460938	0.984401
1985-03-01	2.437500	2.632813	2.421875	2.625000	1.058037
1985-04-01	2.609375	2.796875	2.523438	2.742188	1.105271
1985-05-01	2.726563	2.960938	2.679688	2.937500	1.183994



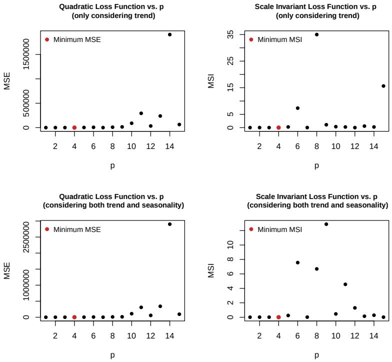
Training and Test Dataset



Possible Solutions

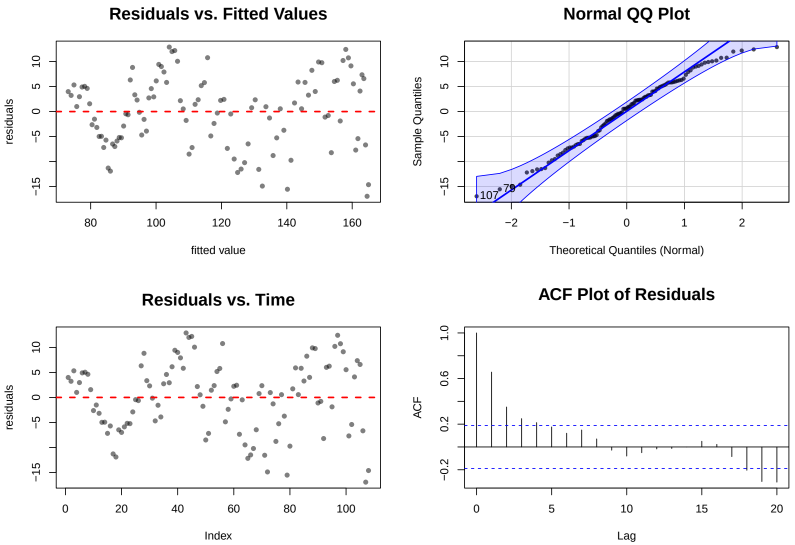
```
##
##  Fligner-Killeen test of homogeneity of variances
##
## data:  JNJ.ts and seg
## Fligner-Killeen:med chi-squared = 16.225, df = 9, p-value = 0.06233
```

Regression Modelling



Regression	MSE	MSI
Only consider the trend	120.4273	0.0034556
Consider both the trend and seasonality	140.2979	0.0041335

Regression Modelling



Regression Modelling

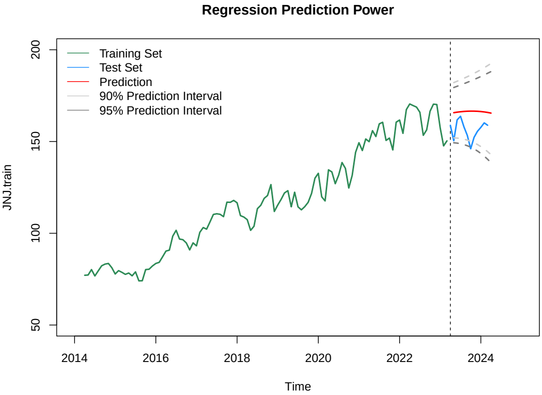
```
##
##  Shapiro-Wilk normality test
##
## data:  residuals(mod.regression)
## W = 0.98043, p-value = 0.1128
```

```
##
##  Fligner-Killeen test of homogeneity of variances
##
## data:  residuals(mod.regression) and segment
## Fligner-Killeen:med chi-squared = 20.584, df = 8, p-value = 0.008338
```

```
##
##  Difference Sign Test
##
## data:  residuals(mod.regression)
## statistic = 0.4977, n = 108, p-value = 0.6187
## alternative hypothesis: nonrandomness
```

```
##
##  Runs Test
##
## data:  residuals(mod.regression)
## statistic = -5.994, runs = 24, n1 = 54, n2 = 54, n = 108, p-value =
## 2.047e-09
## alternative hypothesis: nonrandomness
```

Regression Modelling



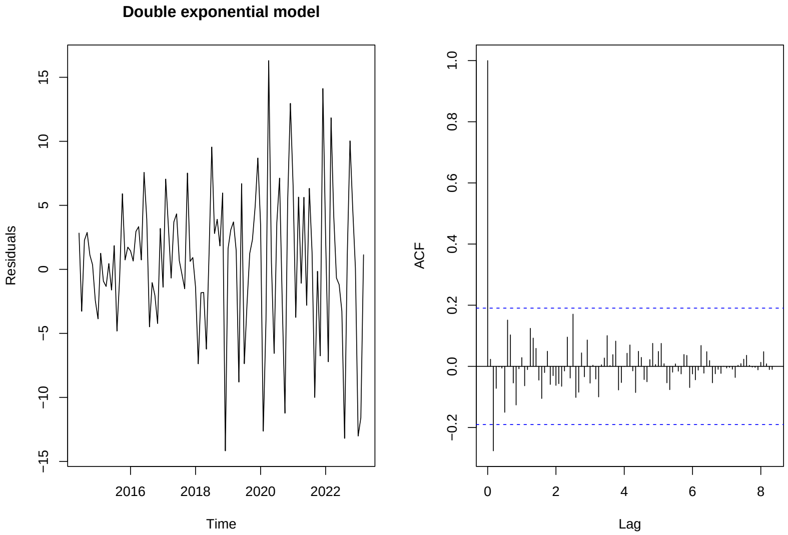
$$APSE = MSE_{pred.} = \frac{\sum_{y \in test}(y - \hat{y})^2}{n_{test}} = 120.5942$$

Smoothing Methods

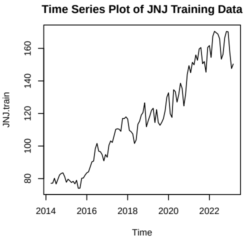
SmoothingModel	APSE
simple exponential	61.92671
double exponential	45.57445
additive HW	62.05079
multiplicative HW	64.51194

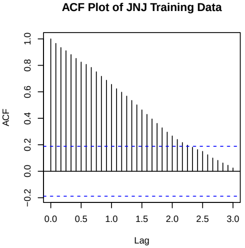
```
## Holt-Winters exponential smoothing with trend and without seasonal component
##
## Call:
## HoltWinters(x = JNJ.train, gamma = FALSE)
##
## Smoothing parameters:
##  alpha: 0.8814822
##  beta : 0.002122442
##  gamma: FALSE
##
## Coefficients:
##          [,1]
## a 150.2403648
## b   0.2402865
```

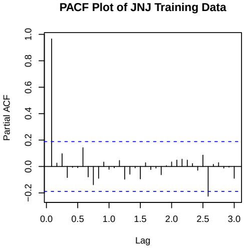
Smoothing Methods



Box-Jenkins Modelling: Model Proposal

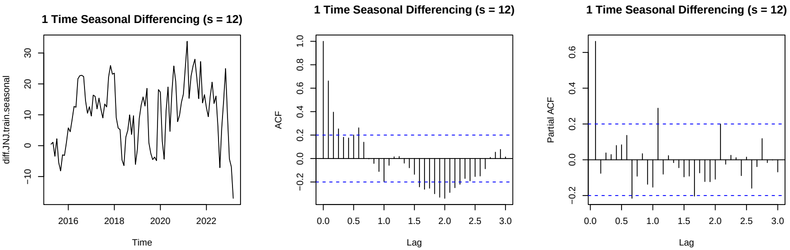






Box-Jenkins Modelling: Model Proposal

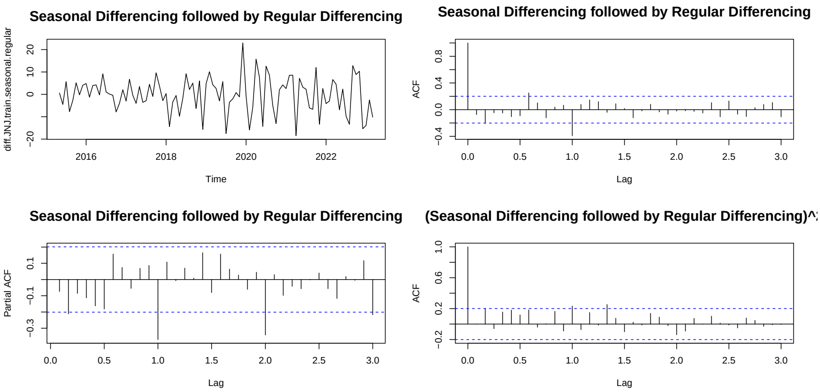
Case 1: start with seasonal differencing $\nabla_{12} X_t = (1 - B^{12}) X_t$.



If it already achieves stationarity: $SARIMA(2, 0, 0) \times (0, 1, 0)_{12}$

Box-Jenkins Modelling: Model Proposal

regular differencing following the seasonal differencing
$\nabla\nabla_{12}X_t = (1-B)(1-B^{12})X_t$

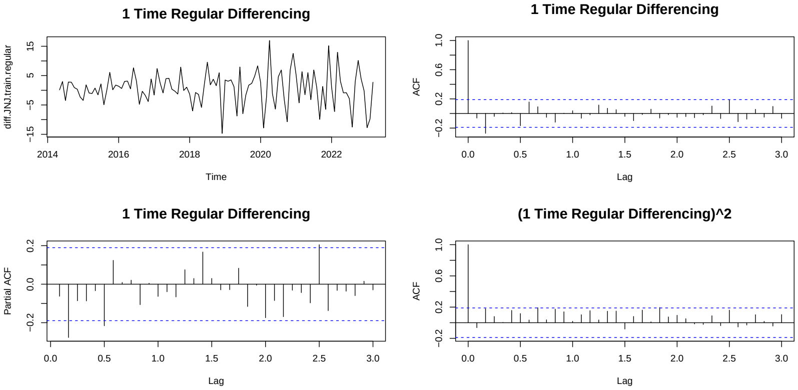


Box-Jenkins Modelling: Model Proposal

$$
\begin{array}{lll}
SARIMA(0,1,1)\times(0,1,0)_{12}, & SARIMA(1,1,1)\times(0,1,0)_{12}, & SARIMA(2,1,1)\times(0,1,0)_{12},\\
SARIMA(0,1,1)\times(0,1,1)_{12}, & SARIMA(1,1,1)\times(0,1,1)_{12}, & SARIMA(2,1,1)\times(0,1,1)_{12},\\
SARIMA(0,1,1)\times(1,1,0)_{12}, & SARIMA(1,1,1)\times(1,1,0)_{12}, & SARIMA(2,1,1)\times(1,1,0)_{12},\\
SARIMA(0,1,1)\times(1,1,1)_{12}, & SARIMA(1,1,1)\times(1,1,1)_{12}, & SARIMA(2,1,1)\times(1,1,1)_{12},\\
SARIMA(0,1,2)\times(0,1,0)_{12}, & SARIMA(1,1,2)\times(0,1,0)_{12}, & SARIMA(2,1,2)\times(0,1,0)_{12},\\
SARIMA(0,1,2)\times(0,1,1)_{12}, & SARIMA(1,1,2)\times(0,1,1)_{12}, & SARIMA(2,1,2)\times(0,1,1)_{12},\\
SARIMA(0,1,2)\times(1,1,0)_{12}, & SARIMA(1,1,2)\times(1,1,0)_{12}, & SARIMA(2,1,2)\times(1,1,0)_{12},\\
SARIMA(0,1,2)\times(1,1,1)_{12}, & SARIMA(1,1,2)\times(1,1,1)_{12}, & SARIMA(2,1,2)\times(1,1,1)_{12}.
\end{array}
$$

Box-Jenkins Modelling: Model Proposal

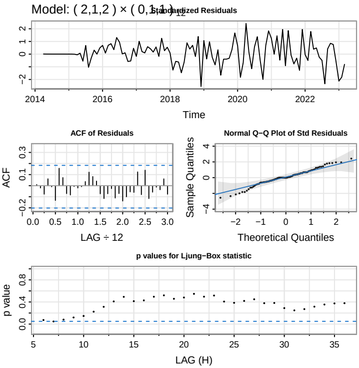
Case 2: Let us also try starting with a regular differencing $\nabla X_t = (1 - B)X_t$.

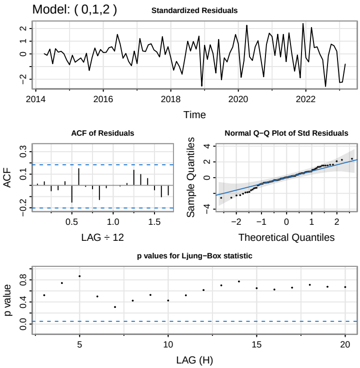


Box-Jenkins Modelling: Model Proposal

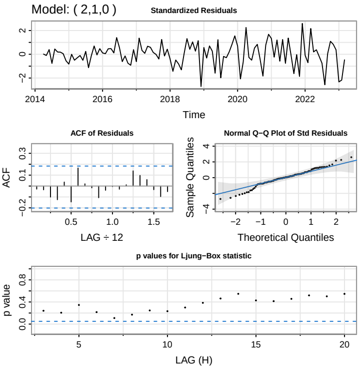
$$
\begin{aligned}
&ARIMA(0,1,0), \quad ARIMA(0,1,1), \quad ARIMA(0,1,2),\\
&ARIMA(1,1,0), \quad ARIMA(1,1,1), \quad ARIMA(1,1,2),\\
&ARIMA(2,1,0), \quad ARIMA(2,1,1), \quad ARIMA(2,1,2).
\end{aligned}
$$

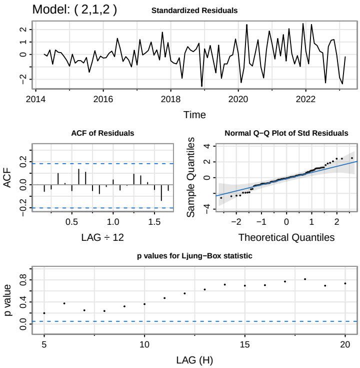
Box-Jenkins Modelling: Model Diagnostics





Box-Jenkins Modelling: Model Diagnostics

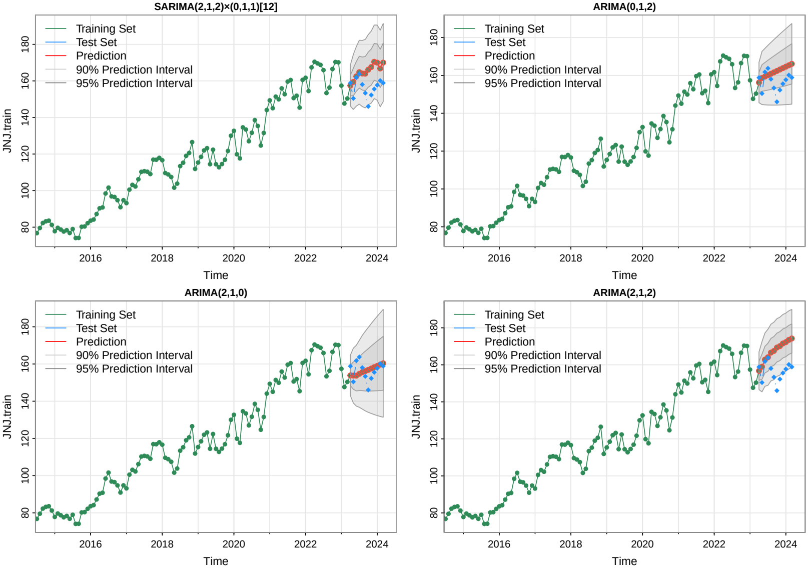




Box-Jenkins Modelling: Fitness and Prediction

Models	AIC	AICc	BIC	APSE
SARIMA(2,1,2)×(0,1,1)[12]	6.596083	6.603179	6.757380	117.58989
ARIMA(0,1,2)	6.263767	6.265944	6.363686	62.46785
ARIMA(2,1,0)	6.297085	6.299262	6.397004	29.37942
ARIMA(2,1,2)	6.237146	6.242698	6.387024	174.16904

Box-Jenkins Modelling: Fitness and Prediction



Conclusion

ARIMA(2,1,0) has the smallest APSE among all the models in three methodologies. Prediction in one year: \$159 to \$167