Airline Industry Stock Analysis

FNCE 2524

Betty Chen, Roopali Negi, Steve Wang, Xi Yang, Ava Zhang

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Business Question

Airline Industry

- Airline Industry today helps drive **$1.7 Trillion** in U.S. economic activity and more than **10 Million** U.S. Jobs
- Due to pandemic, airline industry's growth faced a sudden pause in 2020:
  - In 2019, daily number of passengers fluctuates between 2.1 ~ 2.5 million
  - In 2020, the number dropped to 184,000
  - Airlines' stock prices plunged in 2020 due to the pandemic
    - All major airlines faced over 70% of stock price change in the past 52-week period

Airlines' Challenges & Hopes

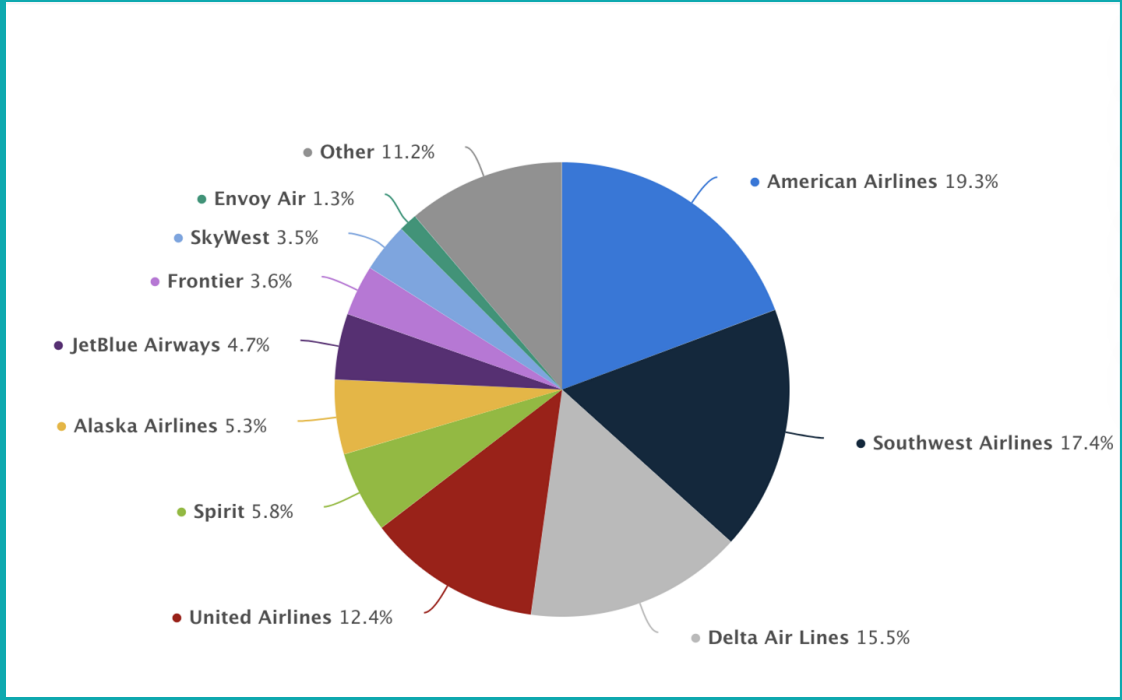
Challenges

- Fleet costs are sunk/deferred
- Aircrafts used as collaterals for extra liquidity
- Employee salaries subsidized by payroll stimulus
- Increase in debt ratio
  - A burden to full recovery
  - Limited investment

Hopes

- Bookings already at 70~80% of 2019 level
- Airlines begun to expand flight schedules
- AAL paid off a $550 million loan received from U.S. government

Domestic Airline Industry Competition Landscape



Is Airline industry stock a good investment in 2021?

Data Background

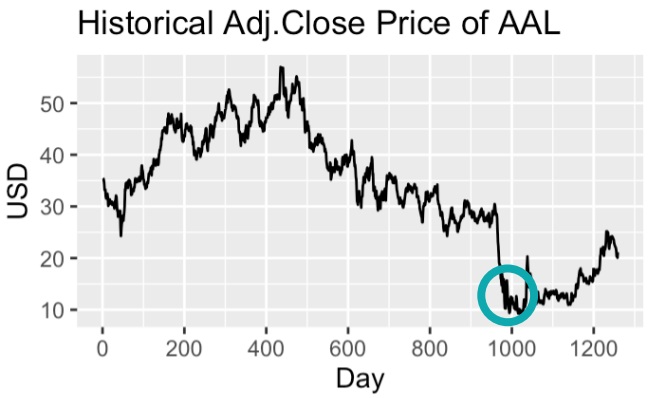
Airlines Chosen: American Airlines (AAL), United Airlines (UAL), Delta Air Lines (DAL)

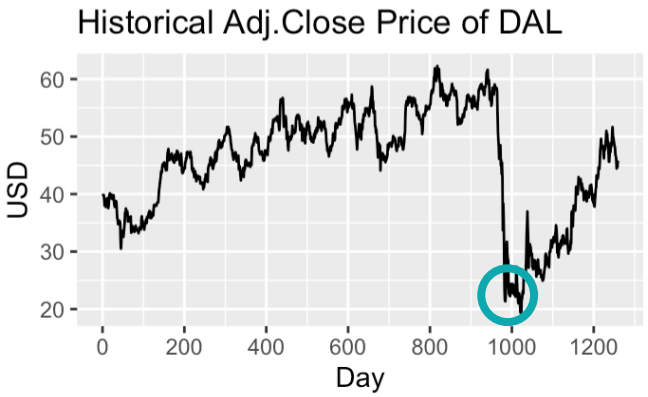
- 3 Major American Airlines that serve both domestic and international flights extensively
- Similar business characteristics and traits for better comparisons and time-series prediction

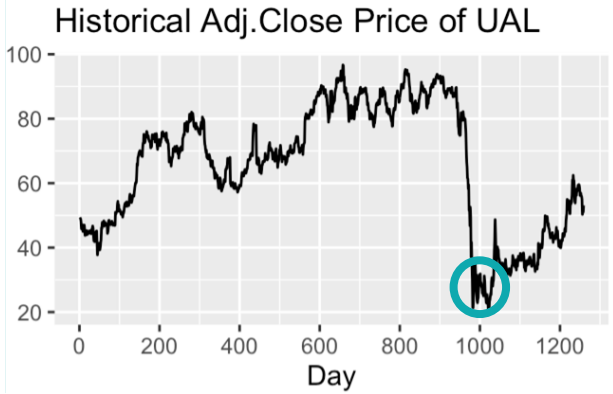
Dataset Description

- Time Series data of **three** Major American Airlines
  - **AAL** - American Airlines
  - **DAL** - Delta Airlines
  - **UAL** - United AIrlines
- Period:
  - **Start: Q2 2016** (4/25/16)
  - **End: Q1 2021**(4/23/21)
- Stock price based on adjusted closing price in USD
- Follows NYSE trading market schedule
- 1259 available trading days data

Historical Adjusted Closing Prices



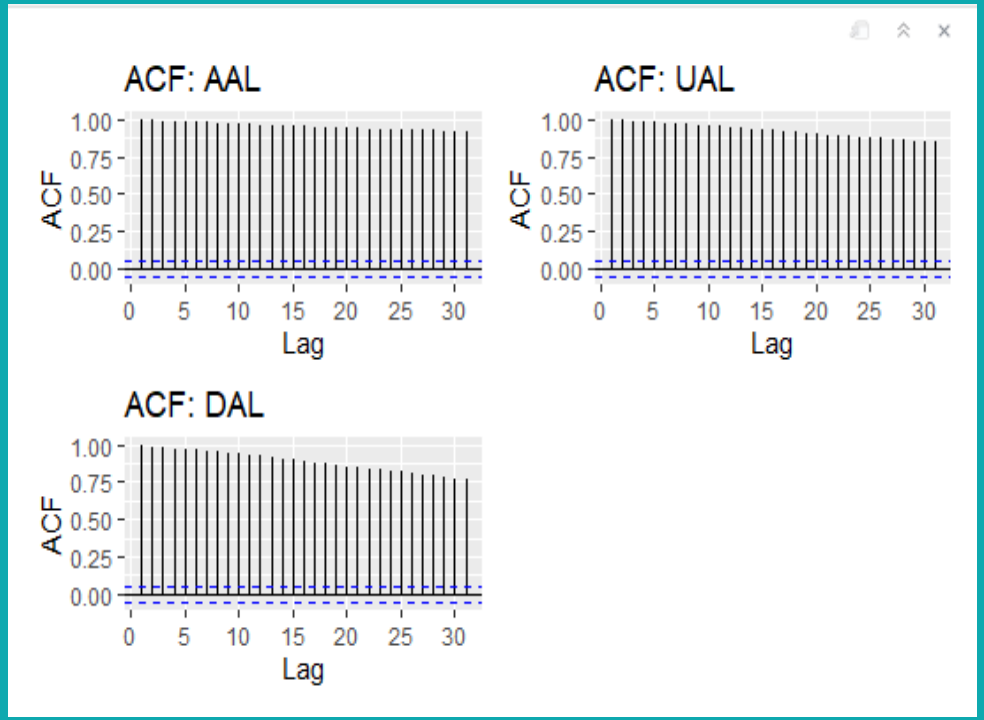




Airline	52-Week Low	52-Week Change	Market Capitalization
AAL	$ 8.25	74.51%	$13.96 B
DAL	$17.51	70.61%	$29.64 B
UAL	$18.18	72.32%	$ 17.31 B

Data Characteristics

- **Non-Stationary**
- ACF plots decrease slowly with no irregularities
- Lines significantly different from 0
- Autocorrelation exists in data



Differencing

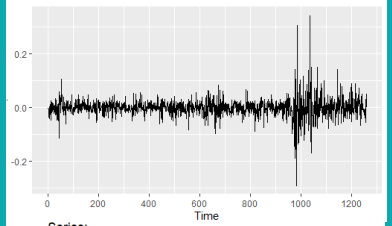
AAL

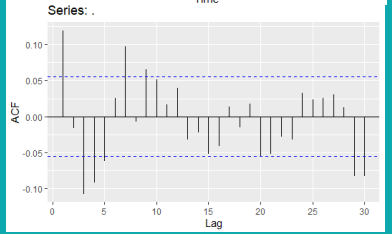
```
######################
# KPSS Unit Root Test #
######################

Test is of type: mu with 7 lags.

Value of test-statistic is: 0.093

Critical value for a significance level of:
                10pct  5pct 2.5pct  1pct
critical values 0.347 0.463  0.574 0.739
```





UAL

```
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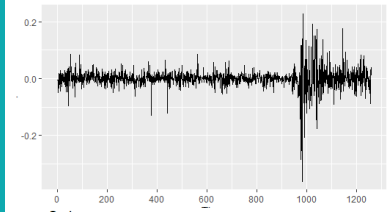

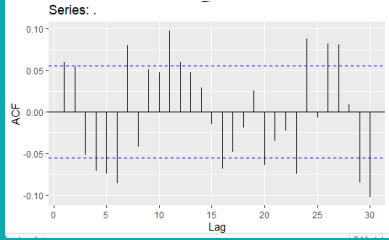

DAL

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# KPSS Unit Root Test #
######################

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critical values 0.347 0.463  0.574 0.739
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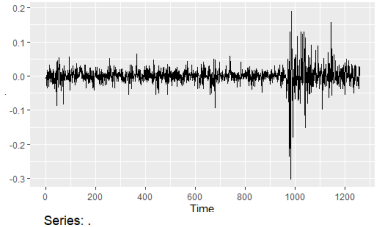
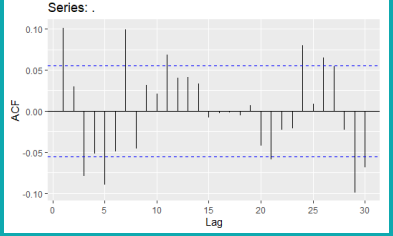
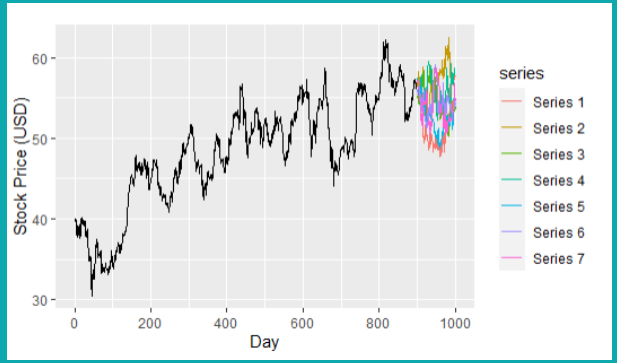


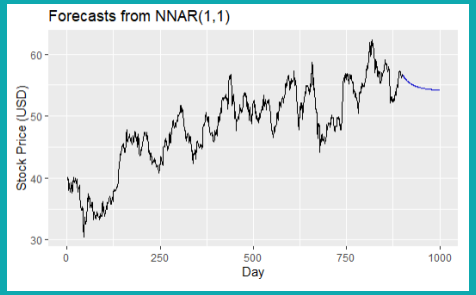


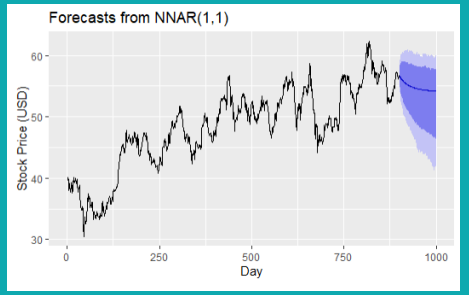
Model Generation

Neural Network

- **NNAR** - Neural Network AutoRegression
- Resistant to outliers using an activation function. IE, Sigmoid, ReLu
- Weights - updated through training trials.
- Forecast combine *n*-step forecast and historical data
- Results averaged through iterations

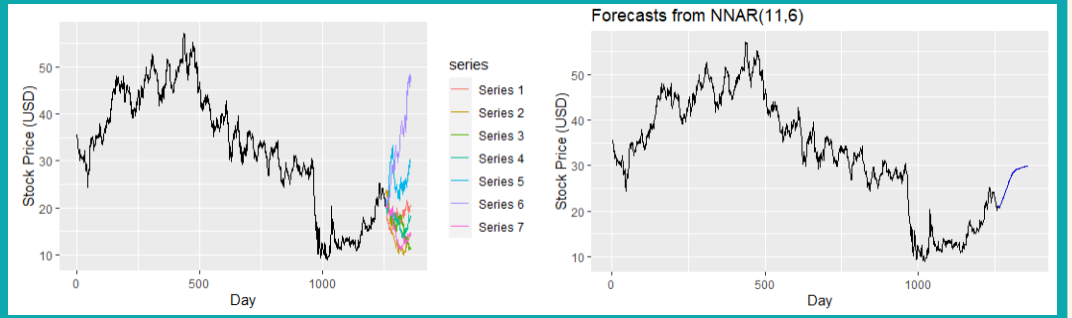






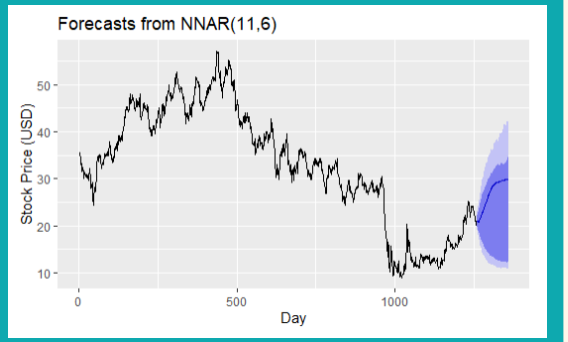
Neural Network Cont'd

- AAL - American Airlines
- NN automatically selects NNAR(11,6)
  - 11 nodes with 6 hidden nodes
- 100 Day Forecast
- 7 trials
- Box-Con transformation



model.desc <chr>	sigma <dbl>	logLik <lgl>	AIC <lgl>	BIC <lgl>	ME <dbl>	RMSE <dbl>	MAE <dbl>	MPE <dbl>	MAPE <dbl>	MASE <dbl>	ACF1 <dbl>
NNAR(11,6)	0.7965329	*NA*	*NA*	*NA*	0.01437458	0.7965329	0.5908602	-0.03904621	2.060662	0.9616992	0.01103979

1 row



Neural Network Cont'd. Pt 3.

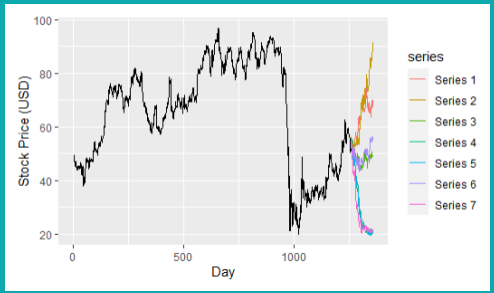
model.desc <chr>	sigma <dbl>	logLik <lgl>	AIC <lgl>	BIC <lgl>	ME <dbl>	RMSE <dbl>	MAE <dbl>	MPE <dbl>	MAPE <dbl>	MASE <dbl>	ACF1 <dbl>
NNAR(31,16)	1.19237	*NA*	*NA*	*NA*	0.01100398	1.19237	0.8533447	-0.02692217	1.317137	0.7673173	-0.00851928

1 row

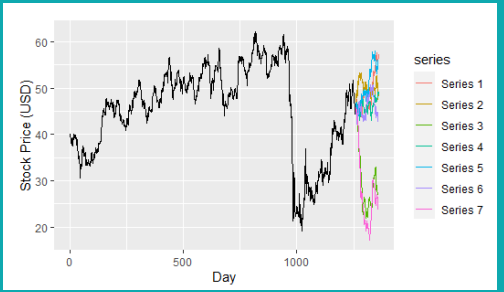
model.desc <chr>	sigma <dbl>	logLik <lgl>	AIC <lgl>	BIC <lgl>	ME <dbl>	RMSE <dbl>	MAE <dbl>	MPE <dbl>	MAPE <dbl>	MASE <dbl>	ACF1 <dbl>
NNAR(30,16)	0.694765	*NA*	*NA*	*NA*	0.009889068	0.694765	0.5089183	-0.006334631	1.106718	0.7424173	0.003464984

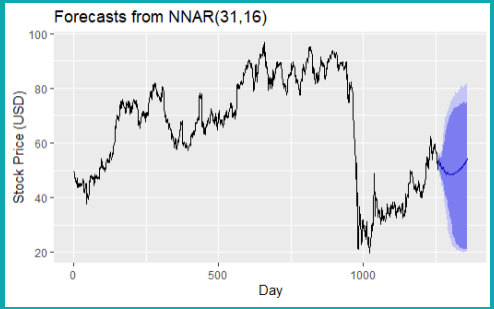
1 row

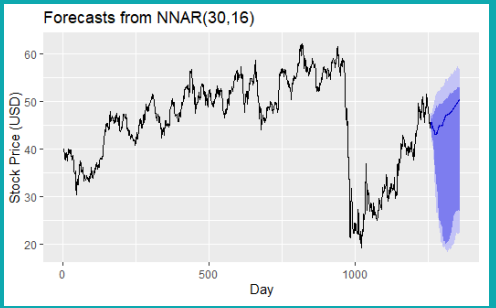
UAL - United Airlines



DAL - Delta Air Lines







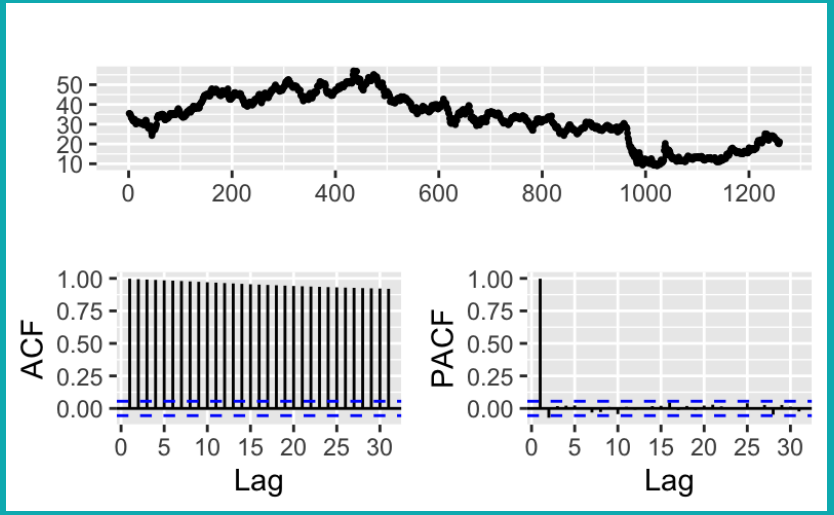
ARIMA Forecast

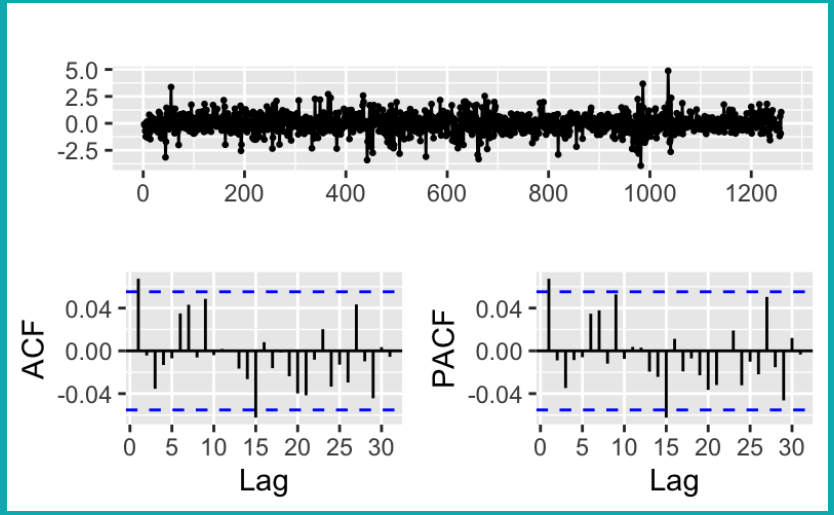
ARIMA (p,i,q) model:

- i: we've already seen that we need to differentiate the data one time, so we can set i equal to 1
- p: Determine P from PACF. Check for spikes beyond the pth spike.
- q: Determine q from ACF. Check for spikes beyond the qth spike

ARIMA Forecast -- AAL

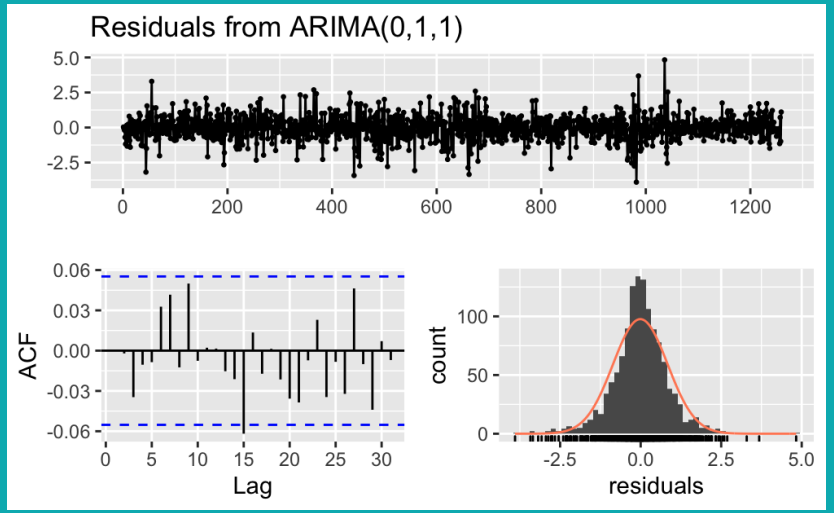
- Autocorrelation function & partial autocorrelation indicated the parameters to be p=1 & q = 1.
- Auto.arima indicates to use ARIMA (0,1,1), stepwise =False indicates same.
- AICc=3156.67 (Lowest from all other combinations tested)

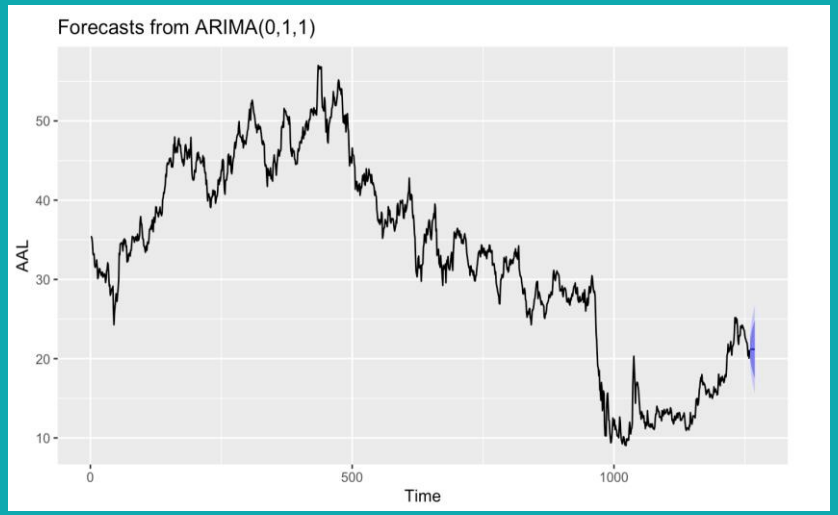




ARIMA Forecast -- AAL

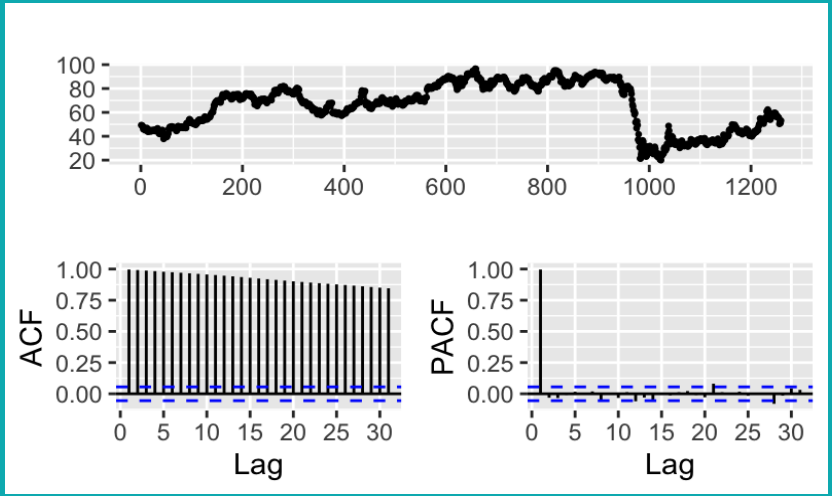
- Plotting the graph of residuals below.
- In ACF plot we see no auto correlations and the distribution is also very close to the normal distribution. Further plotting the forecast from the model.

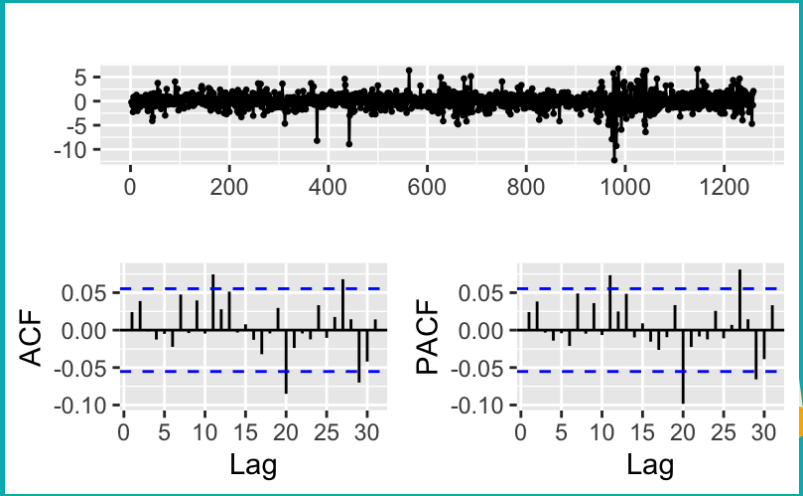




ARIMA Forecast -- UAL

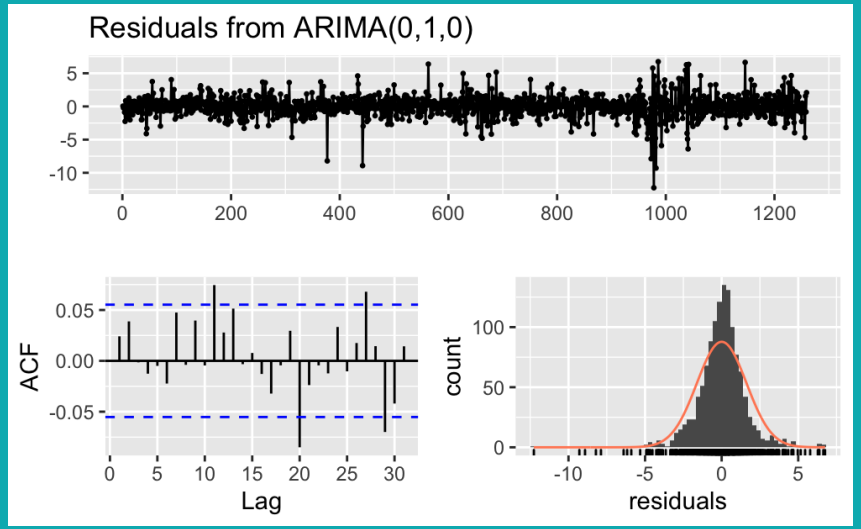
- No spikes in first 10 lags, autocorrelation function & partial autocorrelation indicated p=0 & q = 0
- Auto.arima also indicates to use ARIMA (0,1,0), stepwise =False indicates same.
- AICc=4791.21 (Lowest from all other combinations tested)

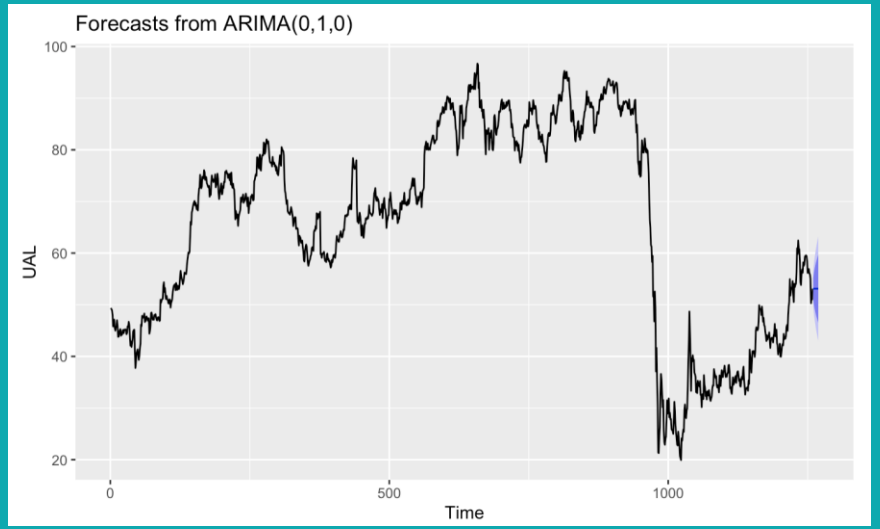




ARIMA Forecast -- UAL

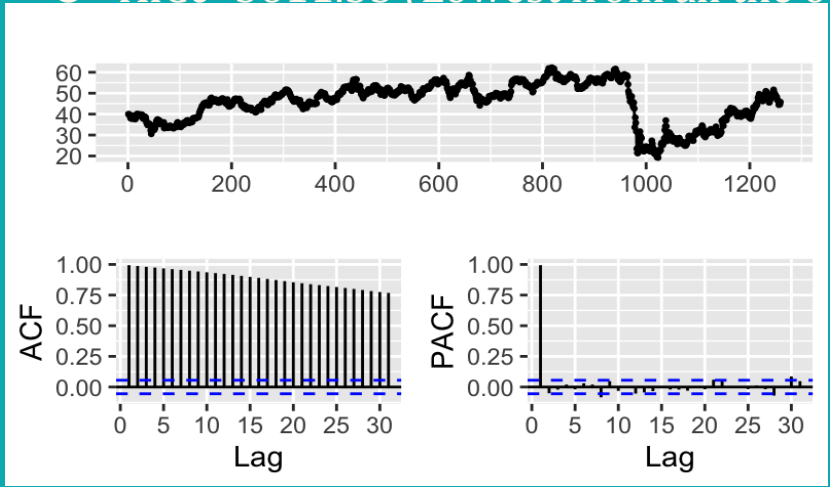
- Plotting the graph of residuals below
- In ACF plot we see no significant auto correlations and the distribution is also very close to the normal distribution. Further plotting the forecast from the model

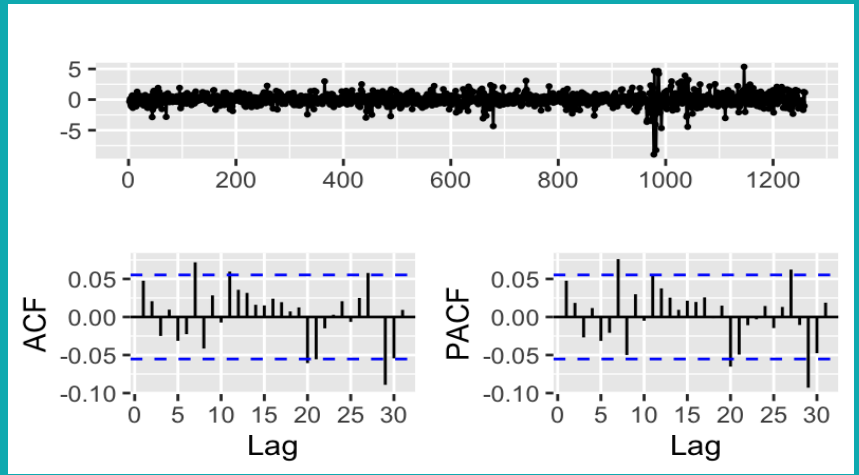




ARIMA Forecast -- DAL

- We do see 1 spike in first 10 lags, autocorrelation function & partial autocorrelation which indicate parameters to be p=1 & q = 1.
- Auto.arima indicates to use ARIMA (0,1,0) but with stepwise=False it gives (2,1,2) & lowest AICc score.
- AICc=3611.33 (Lowest from all the other combinations tested)





ARIMA Forecast -- DAL

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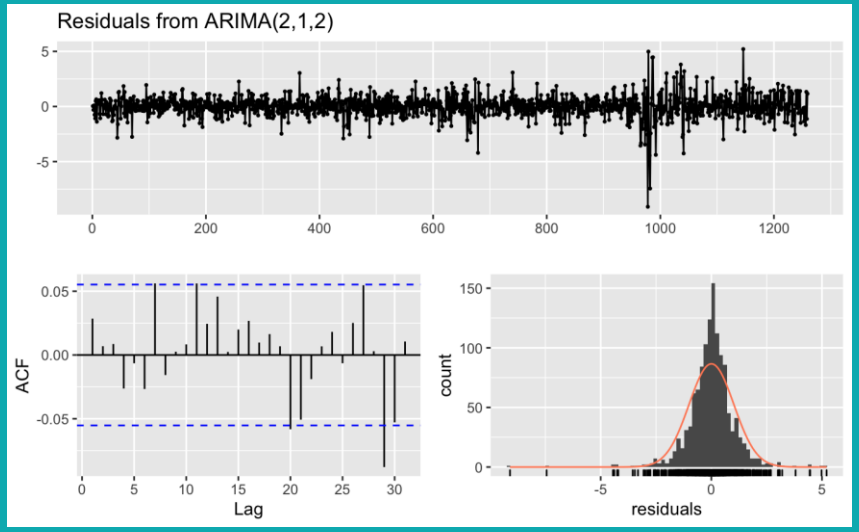
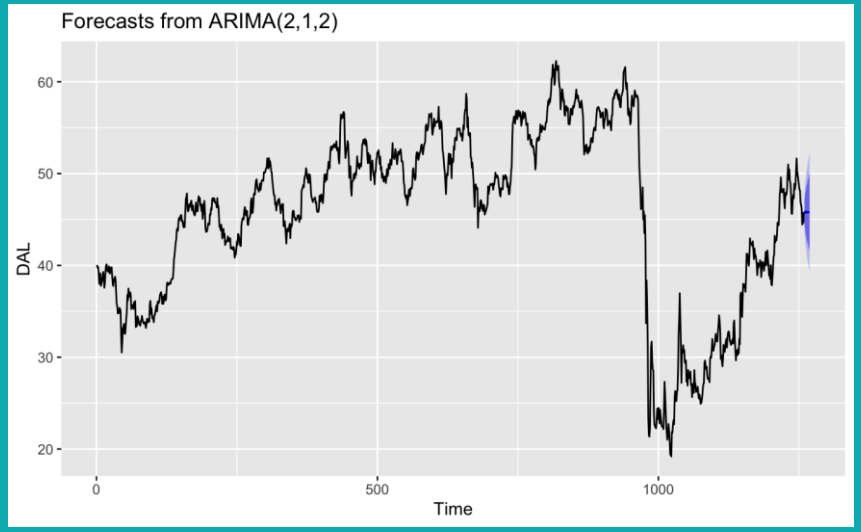
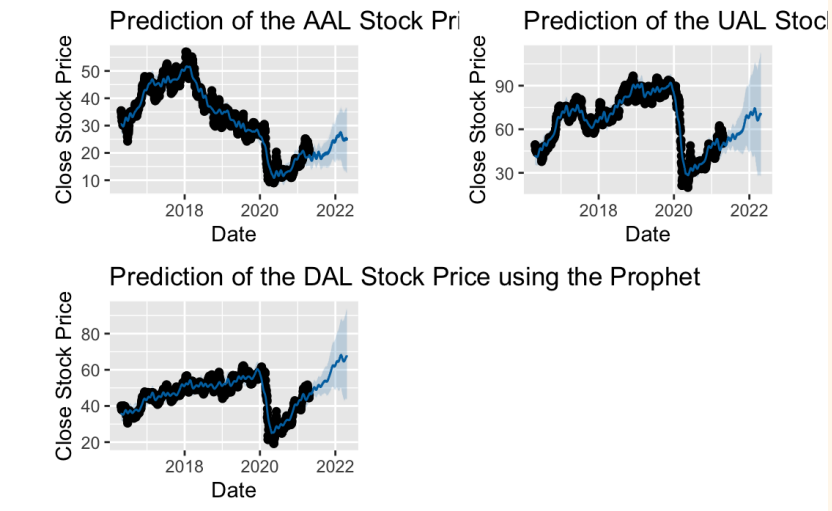
- In ACF plot we see no significant auto correlations and the distribution is also very close to the normal distribution. Further plotting the forecast from the model.



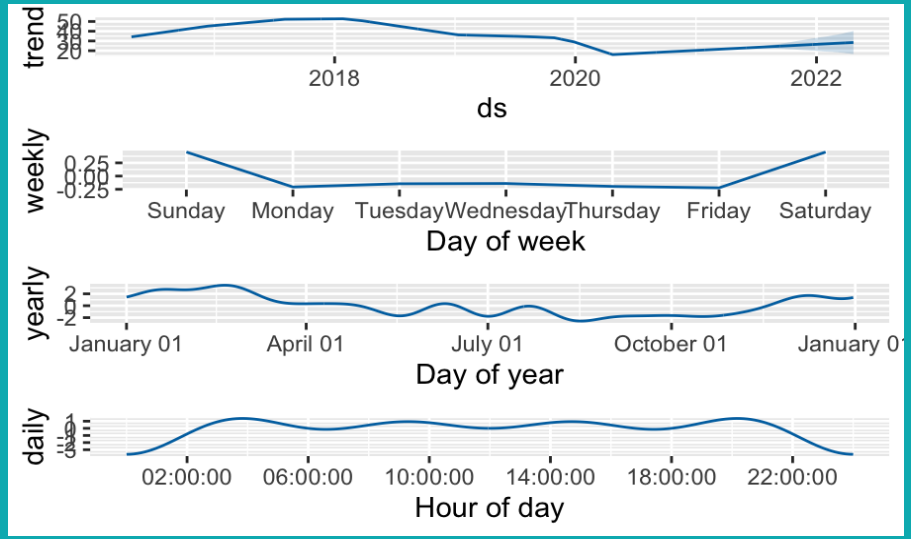


Facebook Prophet Forecast



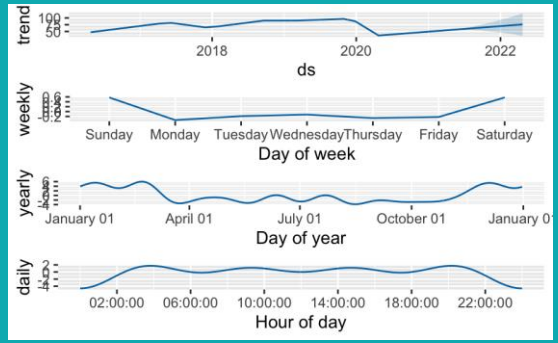
- Non-linear trends are fit with **yearly, weekly, and daily** seasonality

Trends & January Effect

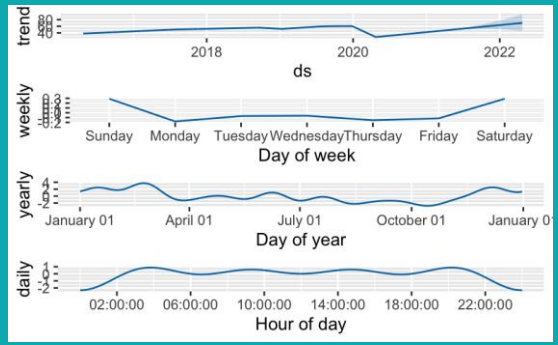


AAL

UAL

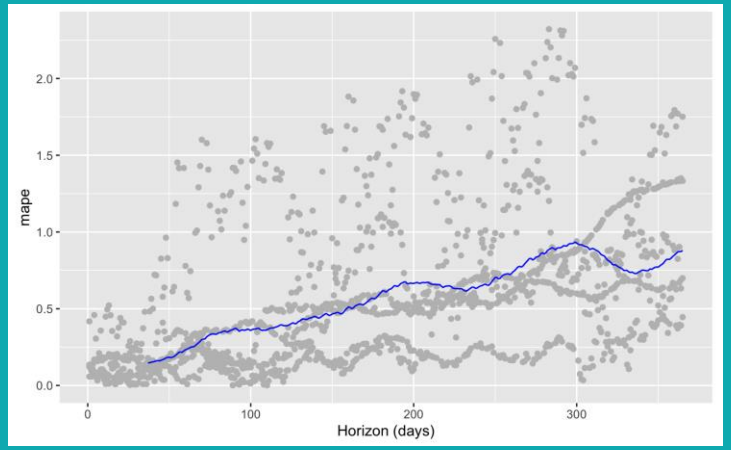


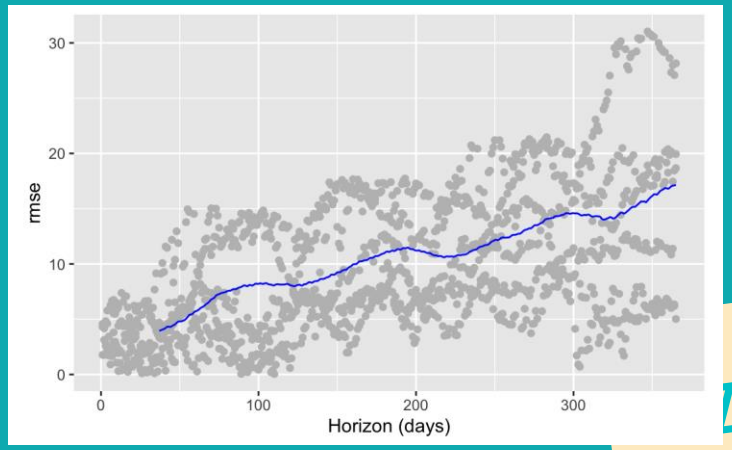
DAL



Cross Validation Performance

-- with 6 cut-off days ('2019-04-01', '2019-06-01', '2019-10-01', '2020-01-01', '2020-02-01', '2020-04-23')

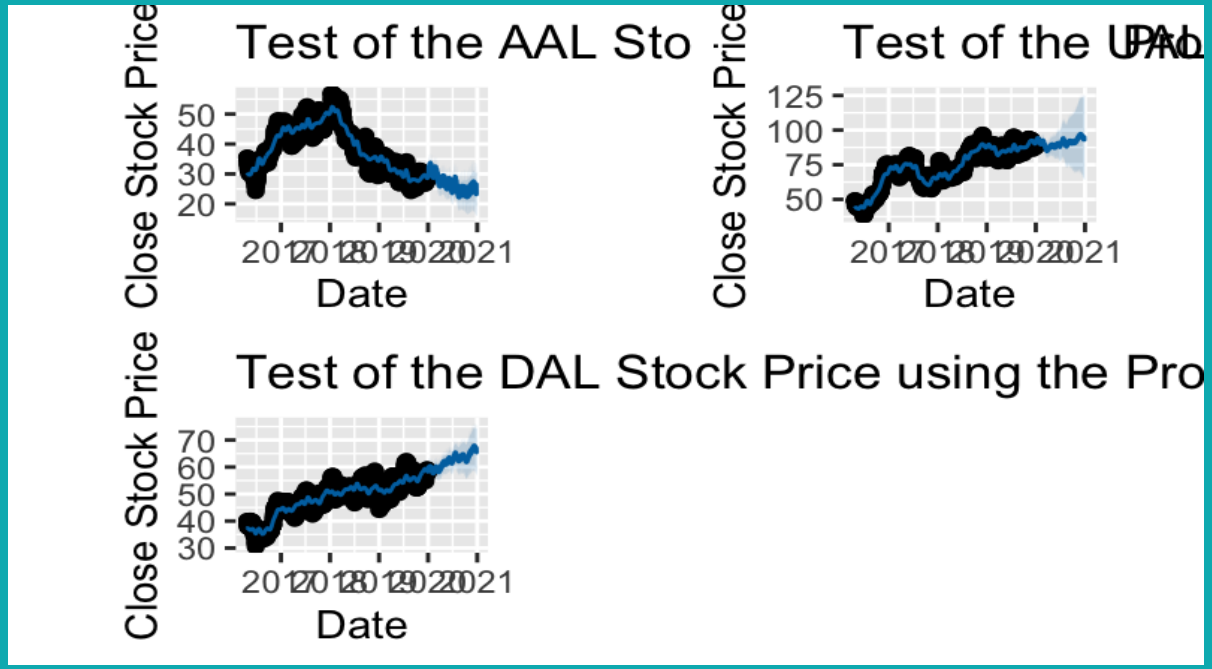




AAL

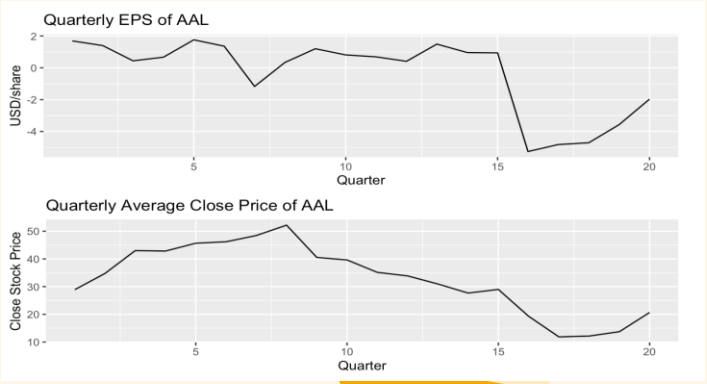
Facebook Prophet Forecast

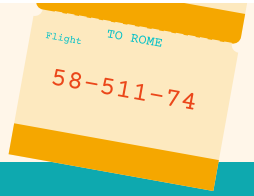
--2020/1/1-2021/4/23 as Test Set



Dynamic Regression
AAL

- Dynamic regression helps find correlation to quarterly price with EPS
- **Basic EPS:** how much a firm's net income was allotted to each share of common stock (from AAL 10-K & 10-Q)
- **Quarterly average price**: calculated base on monthly data from Yahoo! Finance





Dynamic Regression -- AAL

- No evidence of serial correlation
- Ljung-Box test statistics = 0.09, no autocorrelation remained in the residual
- ARIMA model (1,0,0), forecast for next 20 quarters
  - Range of USD 20-30 in stock price

```
Series: AAL.q
Regression with ARIMA(1,0,0) errors

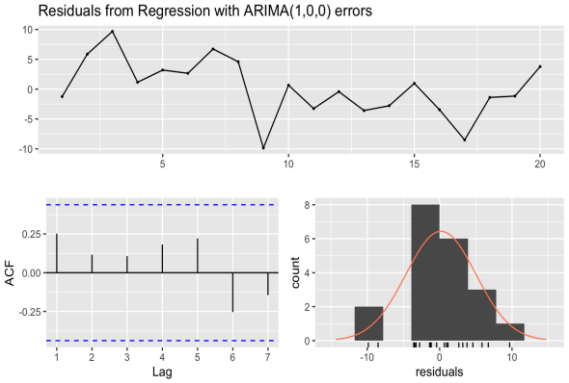
Coefficients:
         ar1  intercept    xreg
      0.8783    29.7363  1.0407
s.e.  0.0895     6.8353  0.6729

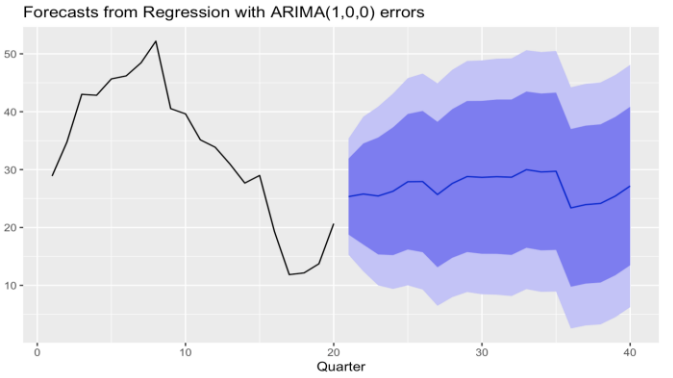
sigma^2 estimated as 26.24:  log likelihood=-60.16
AIC=128.33   AICc=130.99   BIC=132.31

        Ljung-Box test

data:  Residuals from Regression with ARIMA(1,0,0) err
Q* = 6.4718, df = 3, p-value = 0.09078

Model df: 3.   Total lags used: 6
```





Conclusions/ Findings

Model Selection (e.g. AAL)

Model	AICc	RMSE	Recommendation
Neural Network	N/A	0.797	👍👍👍👍👍
ARIMA(0, 1, 1)	3156.67	0.847	👍👍👍👍
Dynamic Regression	130.99	4.723	👍👍👍👍
Facebook Prophet	N/A	Variable on a rolling window/ Cross Validation	👍👍👍👍

Internal and External Validity

Limitation of Data & Model

- Only 5 years historical data
- Adjusted close price, no trading time effects
- Dynamic Regression - only quarterly data, one variable of EPS

Limitation of Technical Analysis:

- COVID19
- Economic environment
- Industry
- Company financials
- Market demand
- Unforeseeable events: airplane crash ect.
- Weather

Investment Recommendation

--Hold !

Findings/Conclusion

All in all, **airline stocks aren't the best stocks to place your hopes on**: **Cautiously Hold/Not Buy**

- Our time series prediction model shows small rewards and strong volatility in future stock prices.
- There’s still much uncertainty of the Covid-19 recovery world-wide.
- The industry is volatile and even the best airlines run on razor-thin margins.
  - They're banking heavily on business travel coming back post-COVID.
  - The talent drain during 20-21 may cause efficiency/effectiveness loss during hardships.
  - Even before covid, the airline industry is very competitive and many airlines close to bankruptcy.
- …

Thank You!