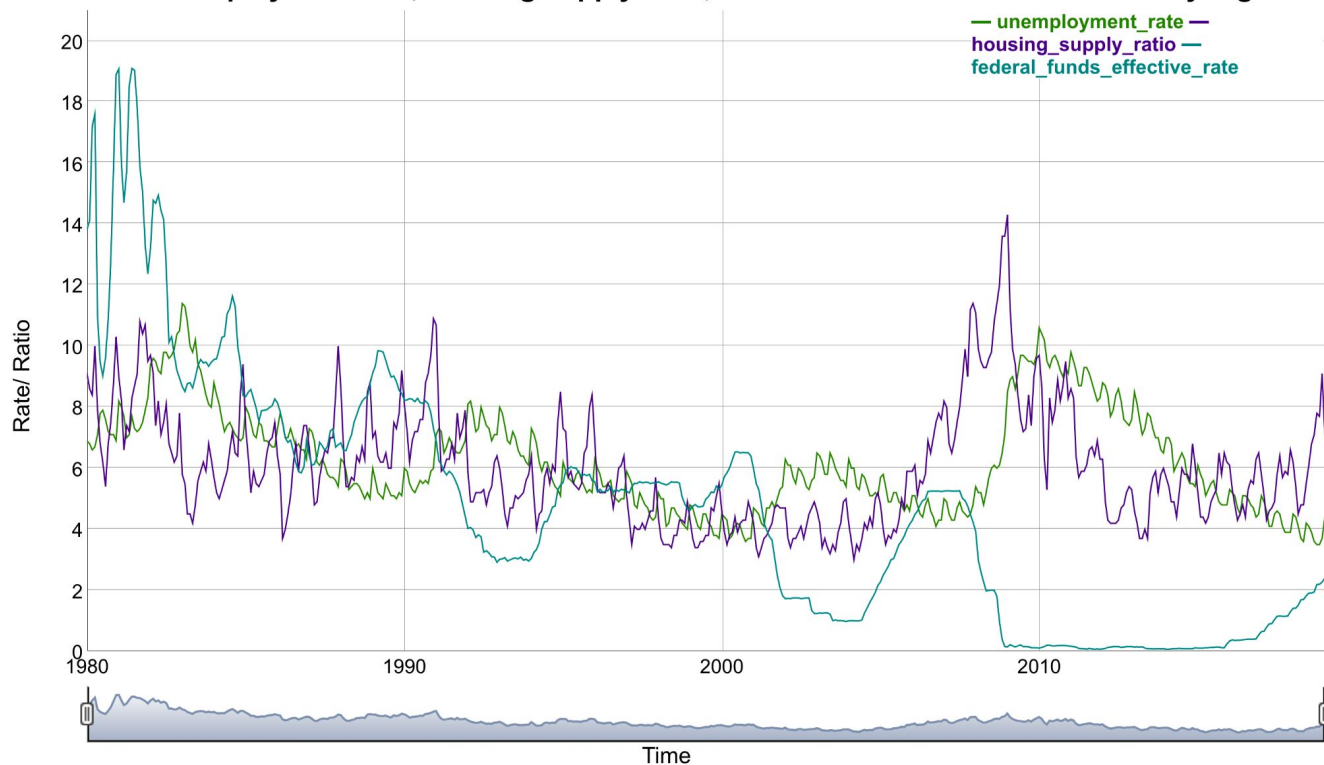


# Predicting US Unemployment Rate Based on Housing Supply Rate and Interest Rate

Robin Lee, Ellen Wei, Xuxin Zhang

# Data Introduction

How does unemployment rate, housing supply ratio, and federal funds effective rate vary together

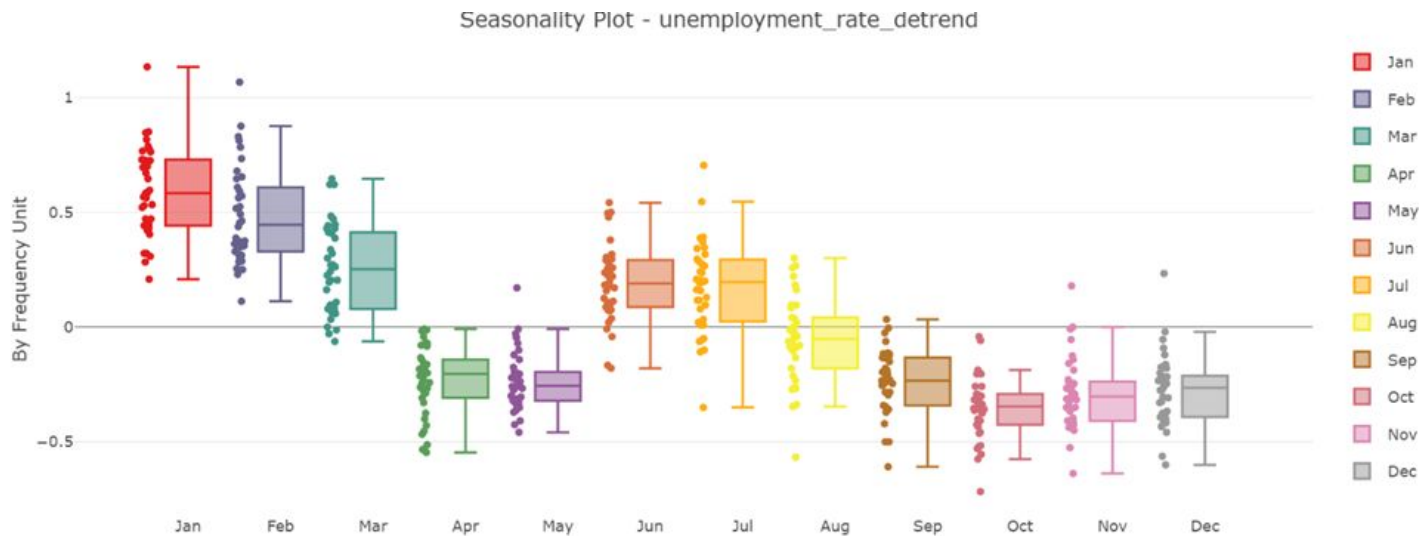
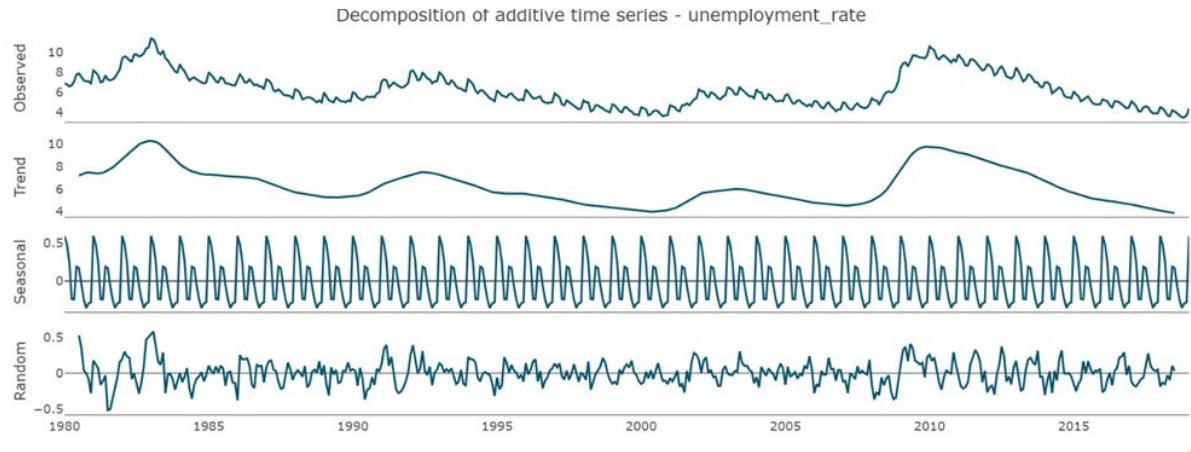


Dependent variable: US  
Unemployment Rate

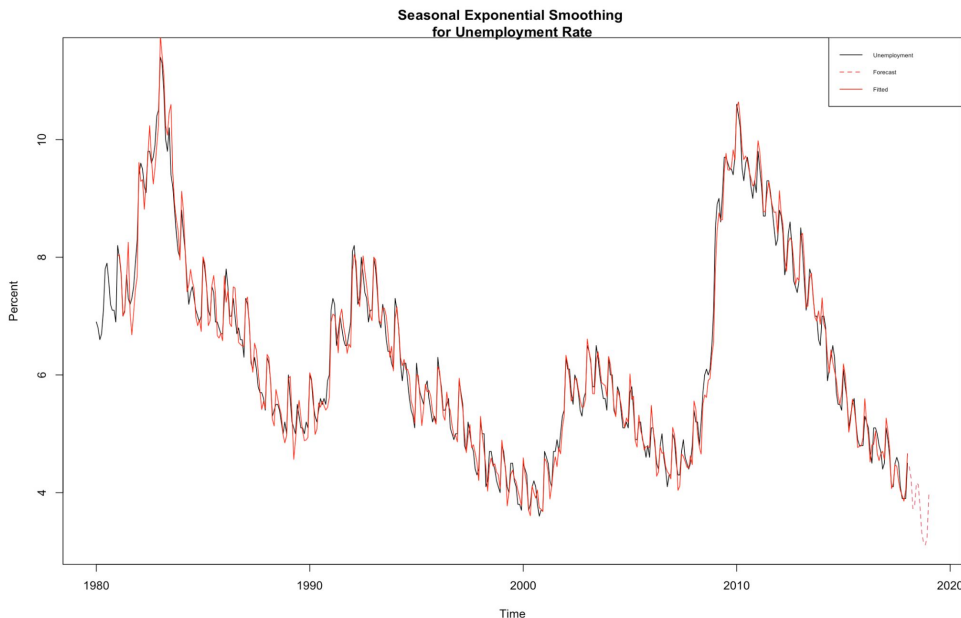
Independent variables:  
Supply of New Housing in  
the US (ratio), Federal  
Funds Effective Rate

January 1980 -January 2019  
Monthly,  
not seasonally-adjusted

# Trend & Seasonality Analysis



# Exponential Smoothing



- The fitted model (solid red line) appears to fit the actual values (black line) fairly well, and we can see an overall negative trend from 2010 onwards.
- **RMSE: 0.2632173**

$$\hat{Y}_{t+h} = (a[t] + h * b[t]) * s[t + 1 + (h - 1) \bmod p],$$

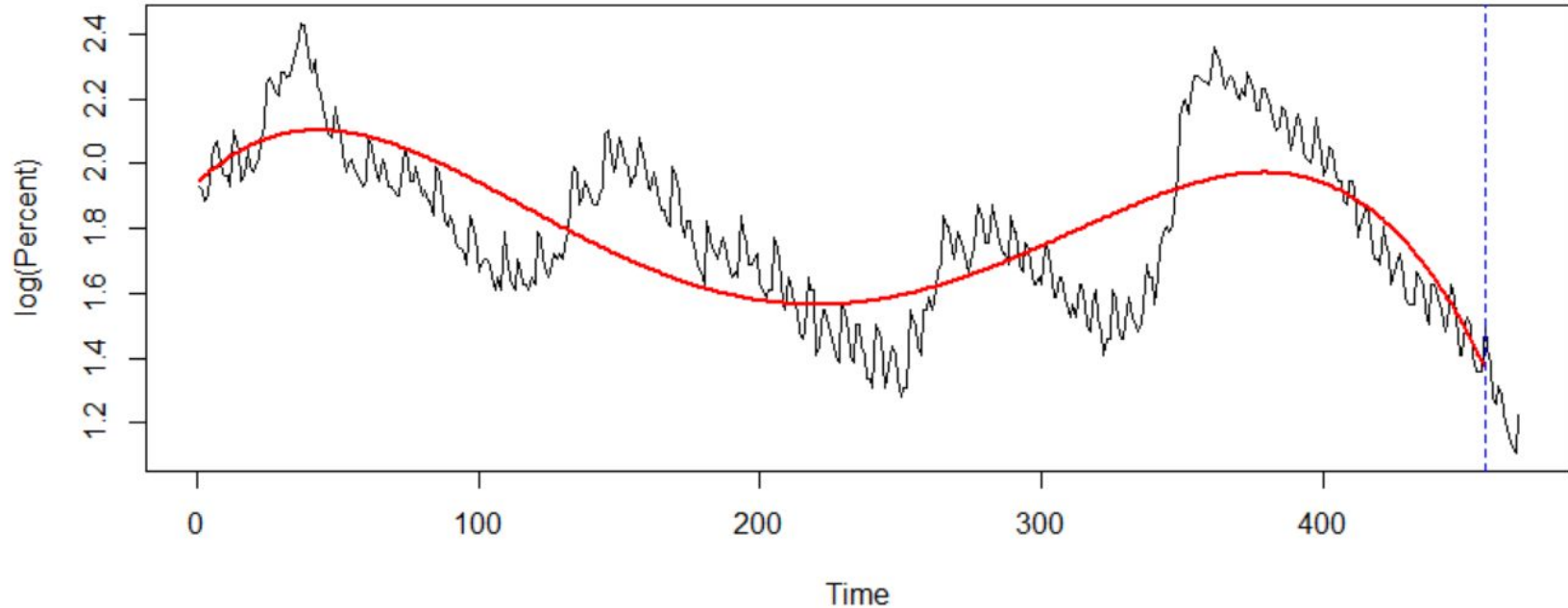
- $a[t] = 0.8428519 (Y[t] / s[t-p]) + (1-0.8428519) (a[t-1] + b[t-1])$
- $b[t] = 0.02833799 (a[t] - a[t-1]) + (1- 0.02833799) b[t-1]$
- $s[t] = (1) (Y[t] / a[t]) + (1-1) s[t-p]$

# Polynomial Regression

4th order Polynomial RMSE (long term): 1.222444

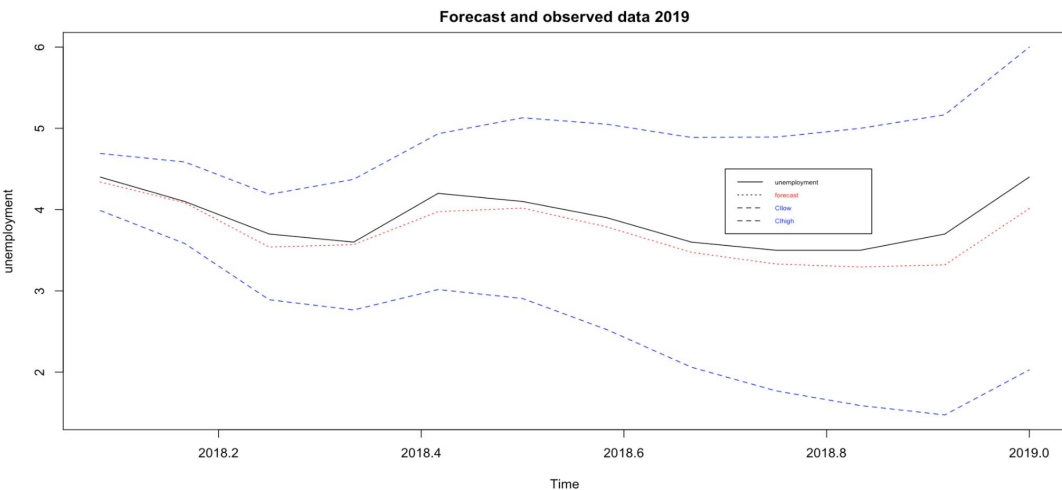
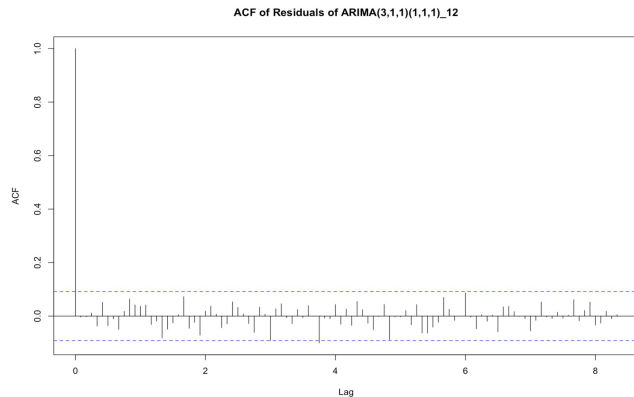
RMSE (short term): 0.485969

**Polynomial Regression Smoother and Forecast**



# ARIMA

- Seasonally differenced the regular differencing
- From ACF and PACF: ARIMA(3,1,1)(1,1,1)<sub>12</sub>
- AIC = -237.105



- We see that the forecast (red dotted line) appears to follow the raw unemployment data (black line) fairly closely, with the upper and lower bands (blue dotted lines) providing a sufficient buffer for the prediction.
- RMSE = 0.56367369

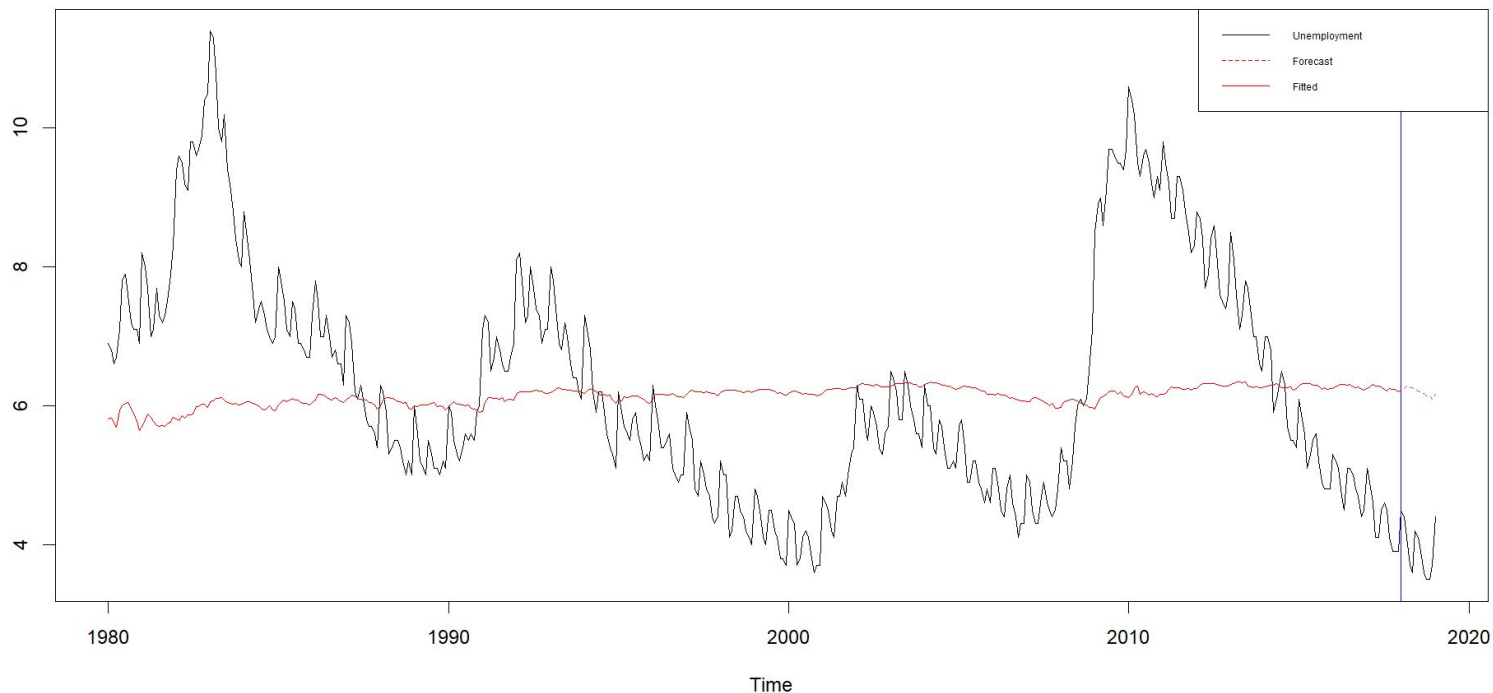
# Multiple Regression with ARMA residuals

RMSE (long-term): 2.328397

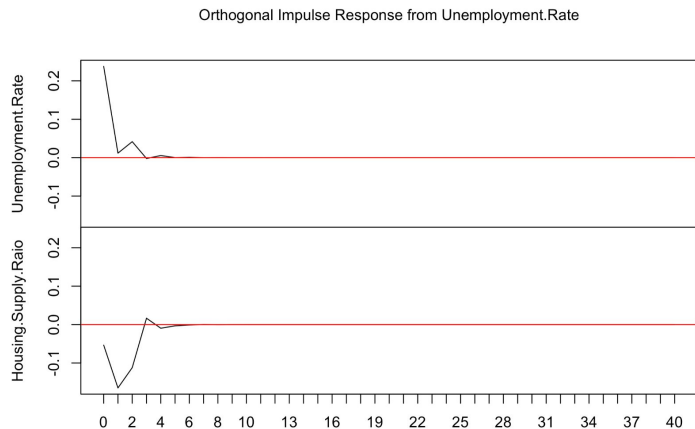
RMSE (short-term): 2.020177

AR(16) model on residuals

**GLS model of Unemployment rate on  
Housing Supply Ratio and Federal Funds Effective Rate**



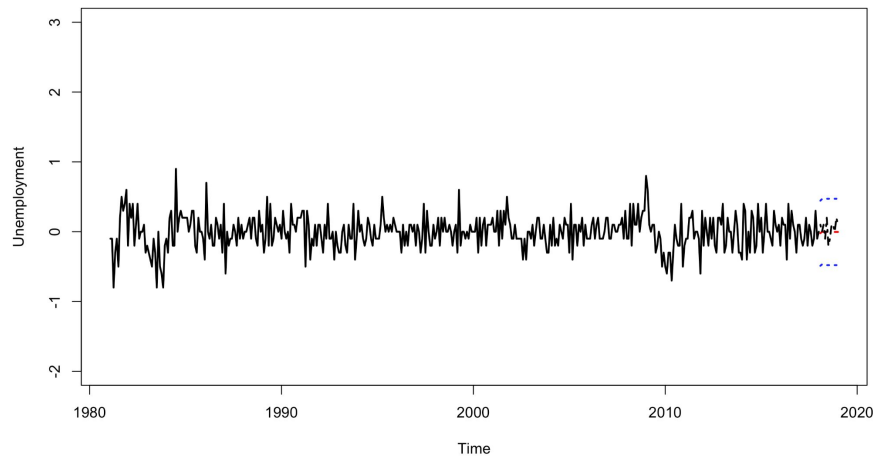
# VAR



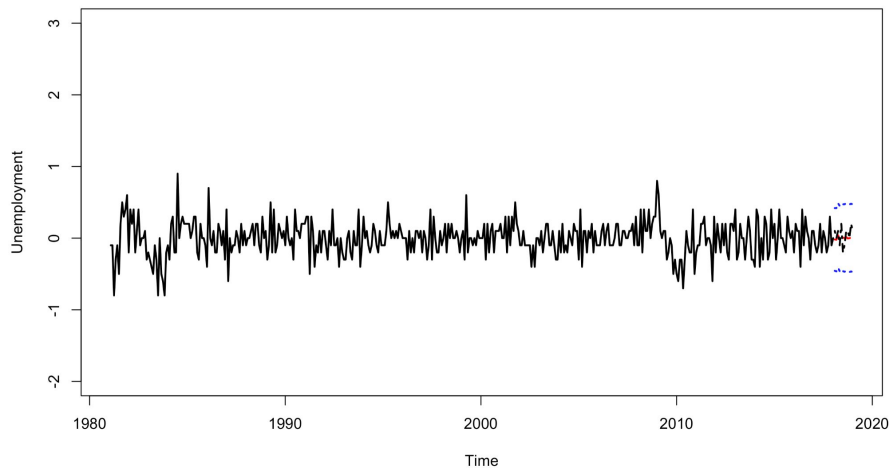
VAR(2) model with RMSE = 0.4452308

VAR(6) model RMSE = 0.4184812

Forecast of change in Unemployment with VAR(2) of Federal Reserver Effective Rate



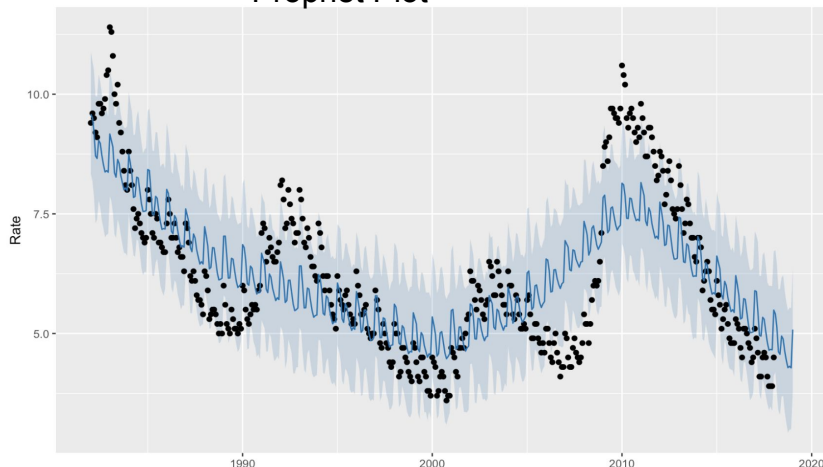
Forecast of change in Unemployment with VAR(6) of Housing Supply Ratio





# Random Forest, GBM, Prophet, Linear regression

Prophet Plot



**RF: 44 trees MAPE: 0.1991295 RMSE: 0.775971**

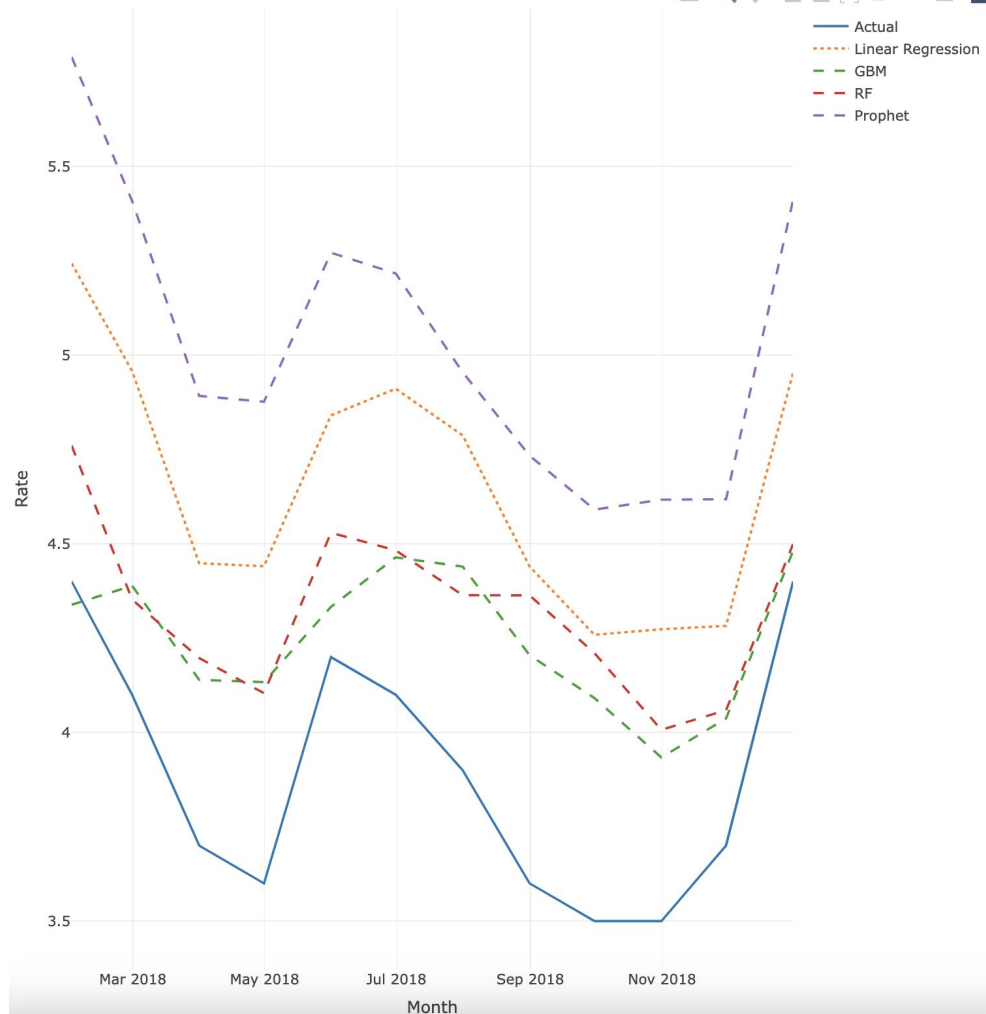
**GBM: 500 trees MAPE: 0.1037769 RMSE: 0.433670**

**Prophet: MAPE: 0.1901292 RMSE: 0.746666**

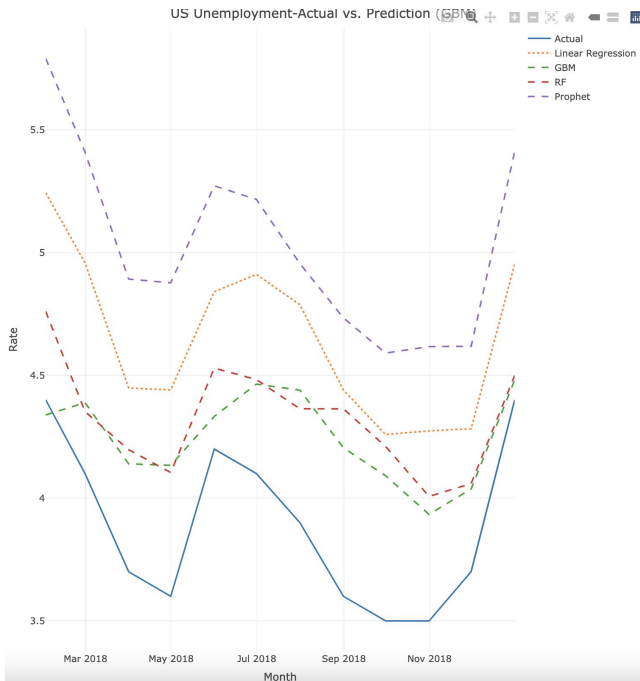
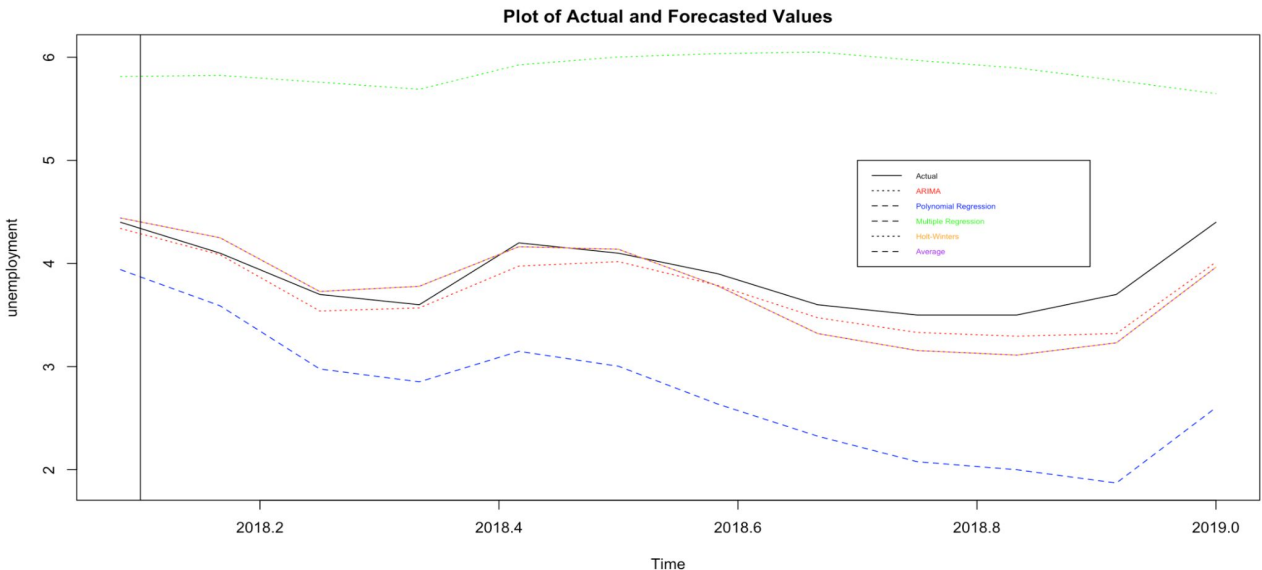
**Linear Regression: MAPE: 0.1974278 RMSE: 0.768995**

Features: lag12, trend, trend^2, month

US Unemployment-Actual vs. Prediction (GBM)



# Model Summary



# Conclusion

Date	Raw Data Values	Exponential Smoothing	Polynomial Regression	Multiple Regression	Diff. Raw Data	VAR	ARIMA	Average Forecast
2018, 2	4.4	4.441674	3.939979	6.247967	0.1	-0.01856	4.69013	4.441674
2018, 3	4.1	4.249191	3.589400	6.278818	0	-0.0221	4.58632	4.249191
2018, 4	3.7	3.728389	2.977189	6.263476	0.1	0.03820	4.18789	3.728389
2018, 5	3.6	3.779068	2.851970	6.263235	-0.1	-0.0056	4.37285	3.779068
2018, 6	4.2	4.163007	3.148521	6.234664	0.2	0.0274	4.93323	4.163007
2018, 7	4.1	4.137926	3.003566	6.210484	-0.2	0.00535	5.12979	4.137926
2018, 8	3.9	3.781335	2.635782	6.184804	-0.1	0.00179	5.05041	3.781335
2018, 9	3.6	3.320676	2.325321	6.172834	0.1	0.01552	4.88785	3.320676
2018, 10	3.5	3.155865	2.078094	6.141373	0.1	-0.0047	4.8918	3.155865
2018, 11	3.5	3.111732	1.999822	6.144801	0.0	-0.0007	5.00000	3.111732
2018, 12	3.7	3.230751	1.871225	6.091753	0.2	0.00705	5.16746	3.230751
2019, 1	4.4	3.963826	2.602641	6.161996	0.1	-0.0011	5.99869	3.963826
	RMSE	0.263217	1.222444	2.328397		0.41848	0.5637	0.263217