Time Series Analysis

Lecture 4

Mixed Autoregressive Moving Average (ARMA) Models

Autoregressive Integrated Moving Average (ARIMA) Models

Seasonal ARIMA (SARIMA) Models

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ARMA Models and MA Models

Modeling Using the British Pound–New Zealand Dollar Exchange Rate, Part 2

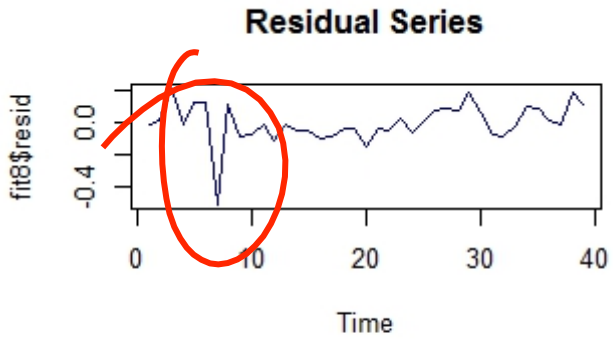
Estimation: ARMA(1,1) Model

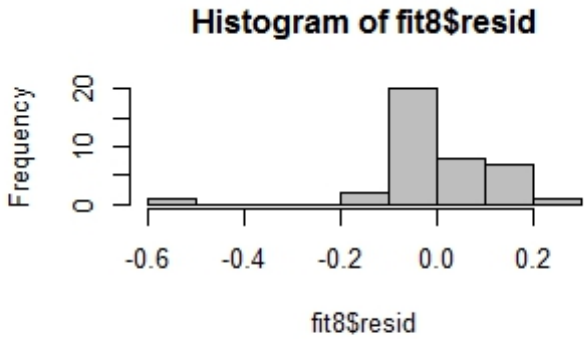
- Based on the time series, ACF, and PACF plots, a low-order ARMA model may do a better job than does a high-order pure MA model.
- Let's estimate a ARMA(1,1) model.
- All the AR and MA parameters are statistically significant.
- Note that the estimated AR parameter is close 1.

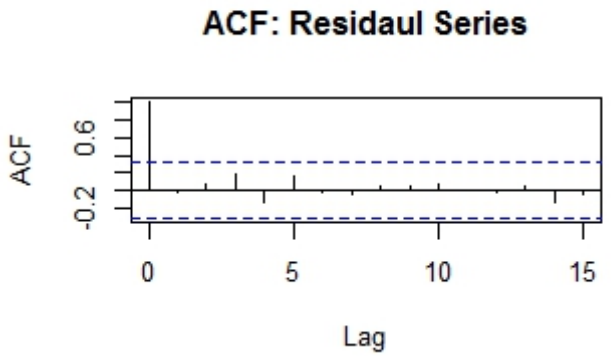
```
> fit8 <- Arima(bpnz$xrate, order=c(1,0,1))
> summary(fit8)
Series: bpnz$xrate
ARIMA(1,0,1) with non-zero mean

Coefficients:
         ar1   ma1  intercept
       0.892  0.53       2.96
s.e.   0.076  0.20       0.24

sigma^2 estimated as 0.0151:  log likelihood=25
AIC=-42   AICc=-41   BIC=-36

Training set error measures:
                    ME RMSE   MAE   MPE MAPE MASE   ACF1
Training set 0.00029 0.12 0.085 -0.21    3 0.85 -0.018
```

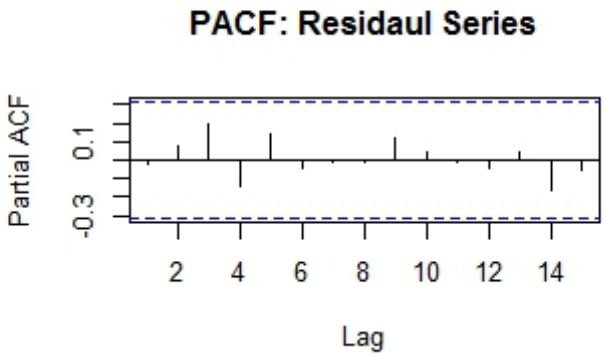
Model Diagnostics

- The ACF, PACF, and Lyung-Box statistics cannot reject the hypothesis that the residual series comes from a white noise process.





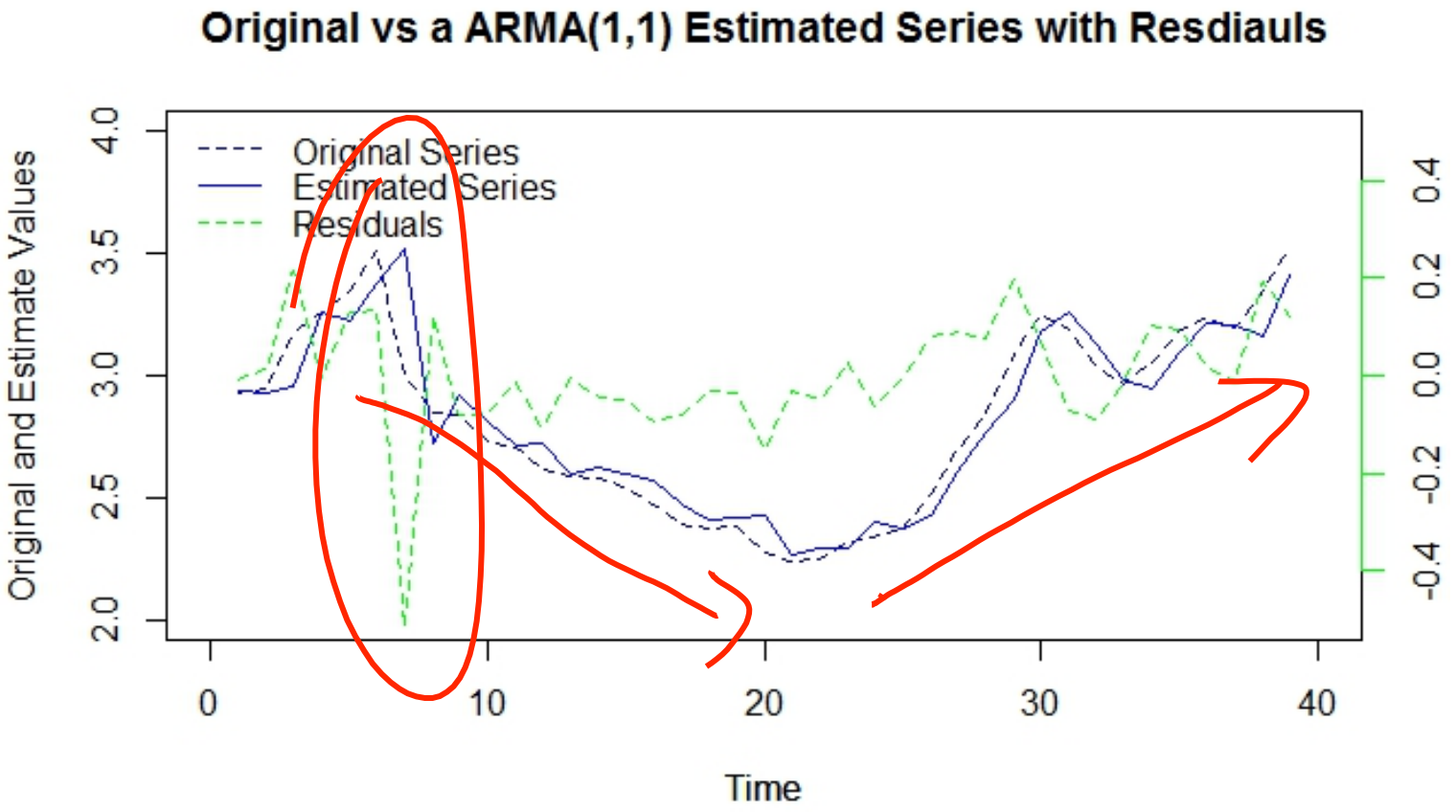





```
> Box.test(fit8$resid, type="Ljung-Box")

 Box-Ljung test

data:  fit8$resid
X-squared = 0.014, df = 1, p-value = 0.9063
```

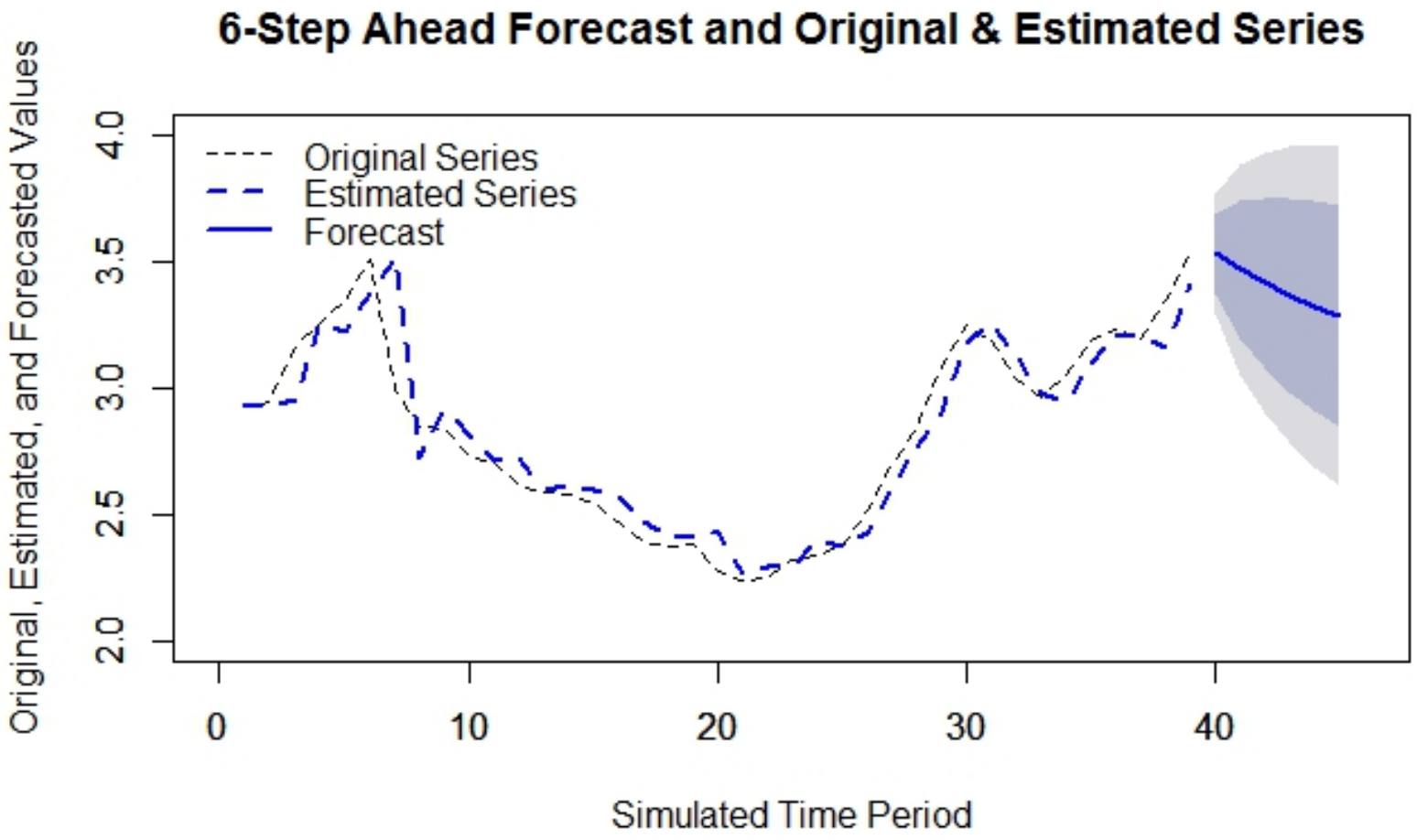
Model Performance Evaluation: In-Sample Fit

- Like that of the MA(5) model, the in-sample fit from the ARMA(1,1) model looks reasonable.



Forecasting

- Notice that the forecast still trends downward, although it does not declines as rapidly as that of the MA(5) model.



Back-Testing and Out-of-Sample Forecasting

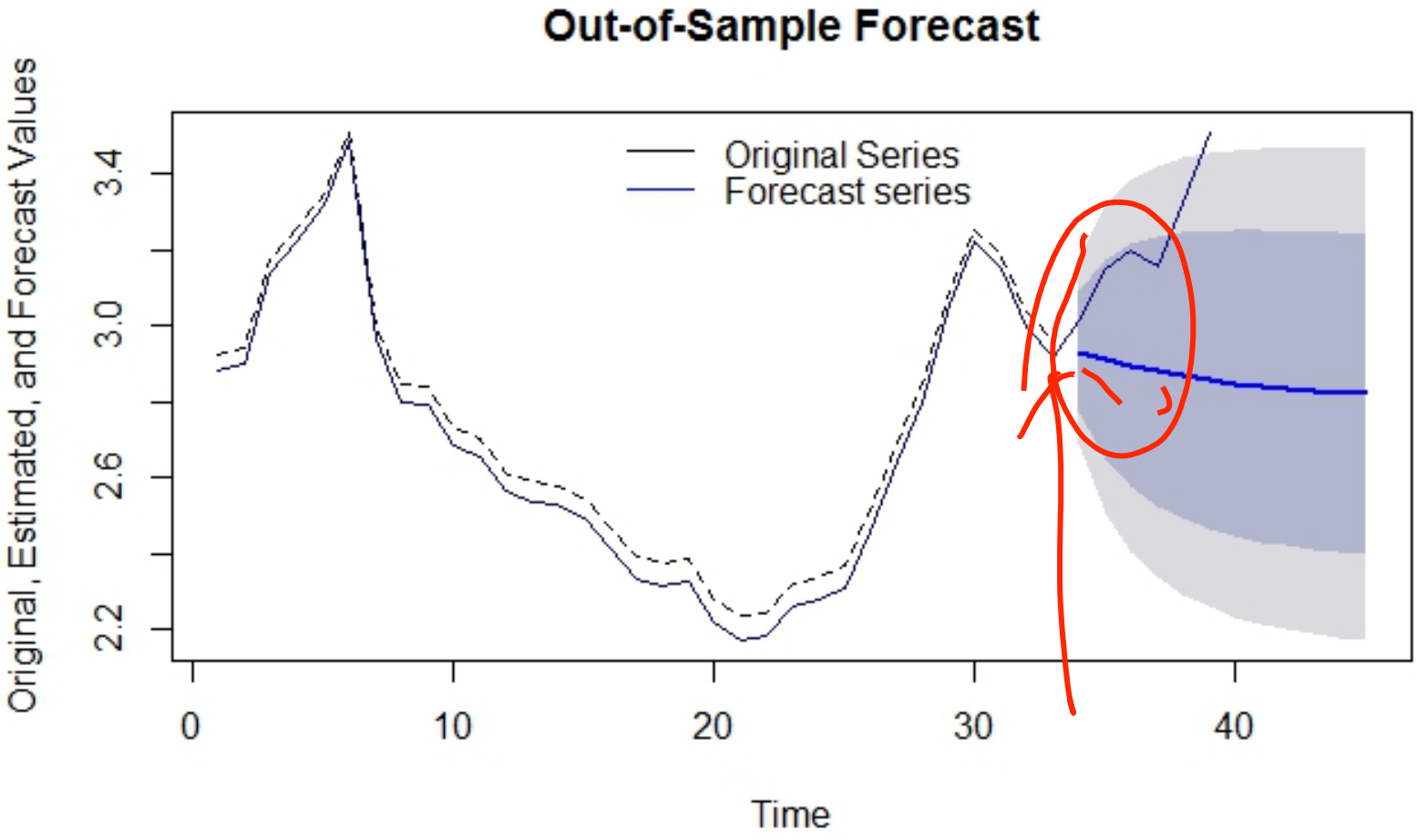
- Reestimate the ARMA(1,1) model using only the first 33 (of the 39) observations in the original series.

- All of the parameters continue to be significant.

```
Series: bpnz$xrate[1:(length(bpnz$xrate) - 6)]
ARIMA(1,0,1) with non-zero mean

Coefficients:
         ar1   ma1  intercept
      0.846  0.48       2.80
s.e.  0.091  0.23       0.18

sigma^2 estimated as 0.0155:  log likelihood=21
AIC=-34   AICc=-32   BIC=-28

Training set error measures:
                     ME RMSE   MAE   MPE MAPE MASE   ACF1
Training set -0.0043 0.12 0.087 -0.37  3.1 0.87 0.0048
```

Back-Testing and Out-of-Sample Forecasting

- The forecasts still deviate from the actual values.
- However, 95% confidence intervals still include the actual values, meaning that the difference is not statistically significant.



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