Time Series Analysis on Quarterly Iron Production in Australia (Mar 1956-Sep 1994)

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Introduction

Studying on the data about quarterly iron production in Australia in 5/1956 to 9/1994, I fitted the best SARIMA model and used the model to make a prediction in the next 3 years(12 quarters).

Background

Australia is the world's largest iron ore exporter. In Australia, iron ore is mainly found in rocks that are more than 600 million years old. Iron production has a huge impact on Australian economic development. So iron production may become a useful measurement of Australia’s economic. Following is the GDP of Australia in 1960-1990.

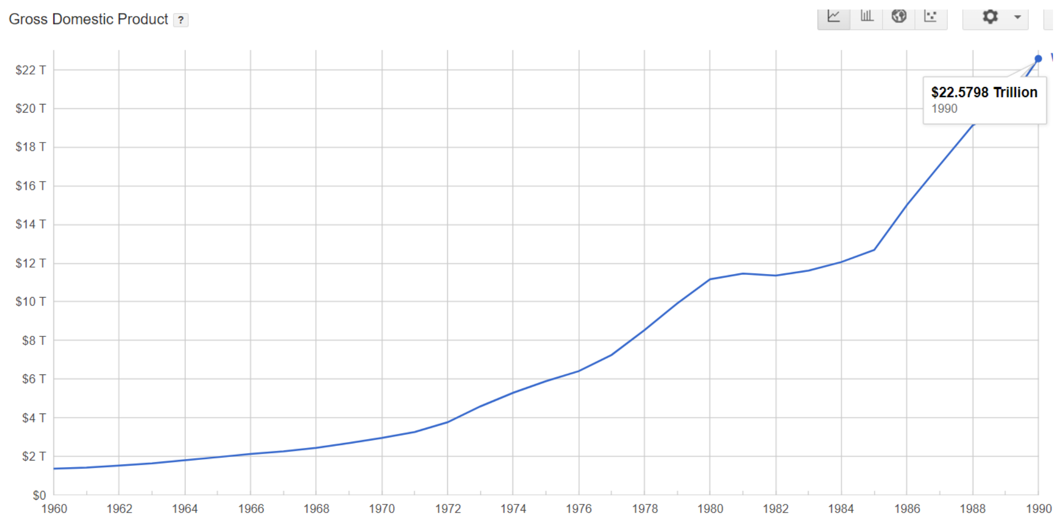

Figure 1

Our data has two variables: time and iron production. Time is recorded by quarter from Mar 1956 to Sep 1994. And iron production is recorded in Thousand tonnes.

Model Specification

The plot in Figure2 show the iron production in Australia. As we can directly see from the plot, the iron production increased in 1960-1975, decreased in 1980-1983, and the increasing trend continued after1983, but slower than before. Compared to the GDP plot in Figure1, GDP increased slow from1980-1983, which indicates some relationship between GDP and iron production.

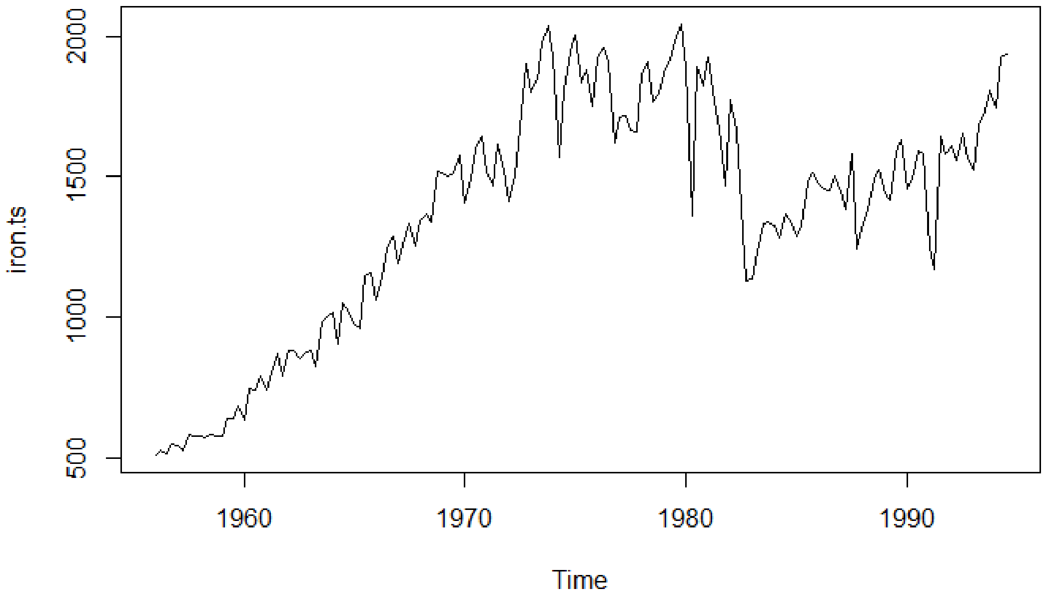

Figure 2

Also notes that it's not stationary because mean of iron production is not 0 and depends on time. Transformation is needed. So I took log and then the suitably lagged and iterated differences. The plot after transformation shows in Figure3 below. The mean became 0, with no obvious pattern. And it looks more stationary apart from the influence at 1980. So I used the transformed data to fit the model.

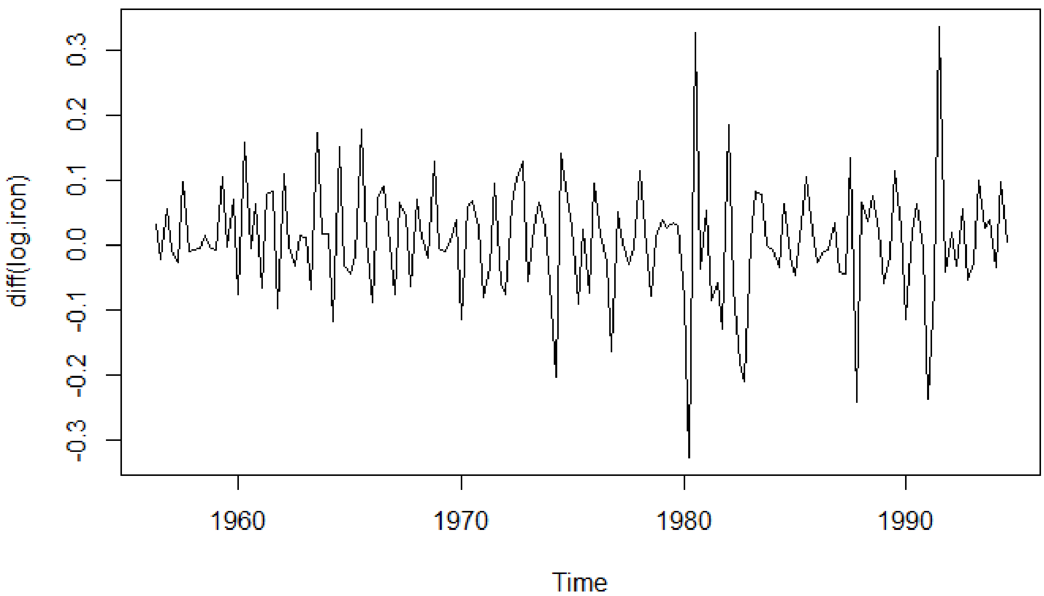

Figure 3

Check the ACF and PACF of the transformed data, see in the Figure4, we might feel that the ACF is cutting off at lag 2 and the PACF is cutting off at lag 1.

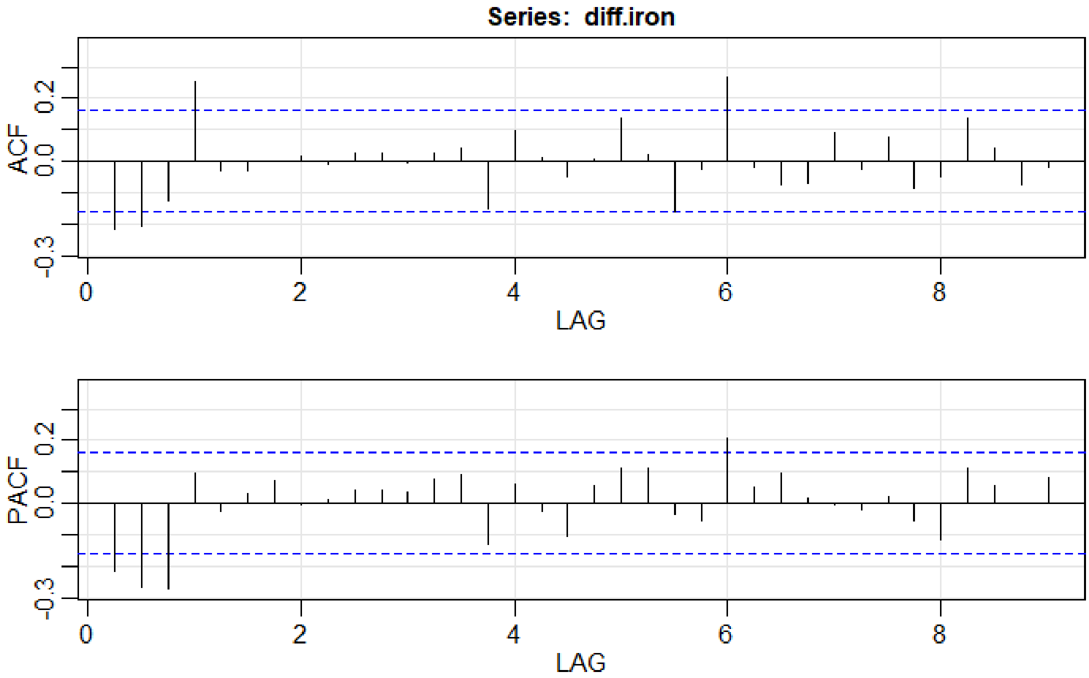

Figure 4

Model Fitting and Diagnostics

Fit the SARIMA model:

From the result of ACF and ACF, I tried several models, and finally find SARIMA(1,1,2,0,1,2,4) fitted the transformed data best with least AIC= -4.012269.

Model Diagnostics:

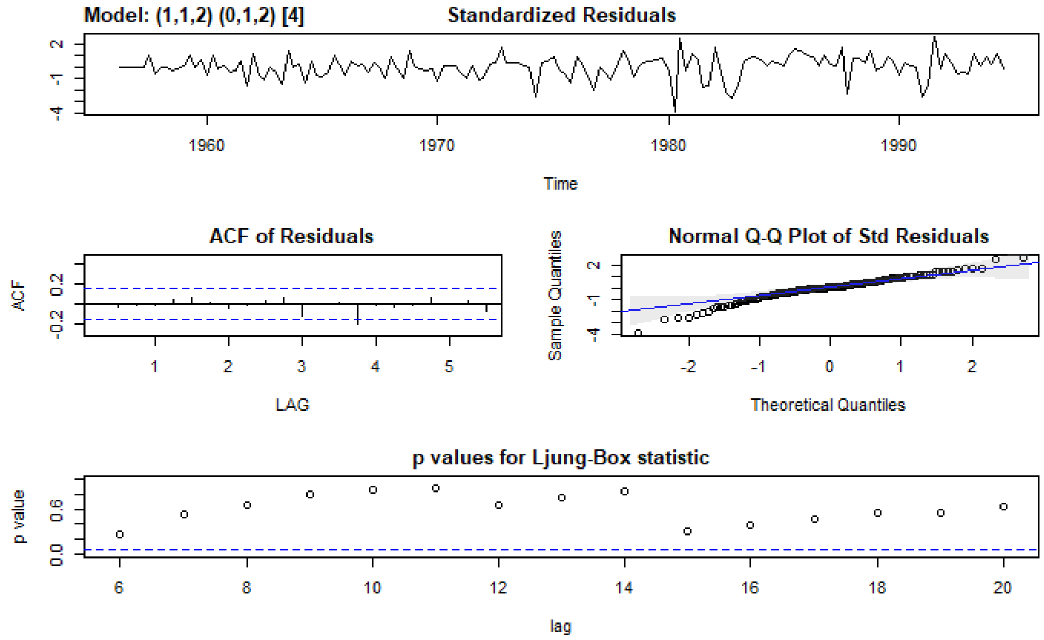

Figure 5

See in the Figure5 above.

The residual plot shows no obvious pattern, which indicates the independence. Notice that there are outliers at 1980-1983ACF plot also shows that the residuals are approximately uncorrelated, behaving a white noise process.

The normal Q-Q plot of the residuals shows departure from normality at the tails may due to the outliers in the 1980-1983.

Then check the Ljung-Box Test. The p-value of Q-statistic is significant, which supports the whiteness of the residuals.

Above all, our model fitted the transformed data well.

Forecasting

Use our final model SARIMA (1,1,2,0,1,2) to forecast the 3 years (12 quarters) iron production after 1990. See the Figure6 below. The difference point is mainly above 0 line, which means the iron production will increase in 3 years after 1990.

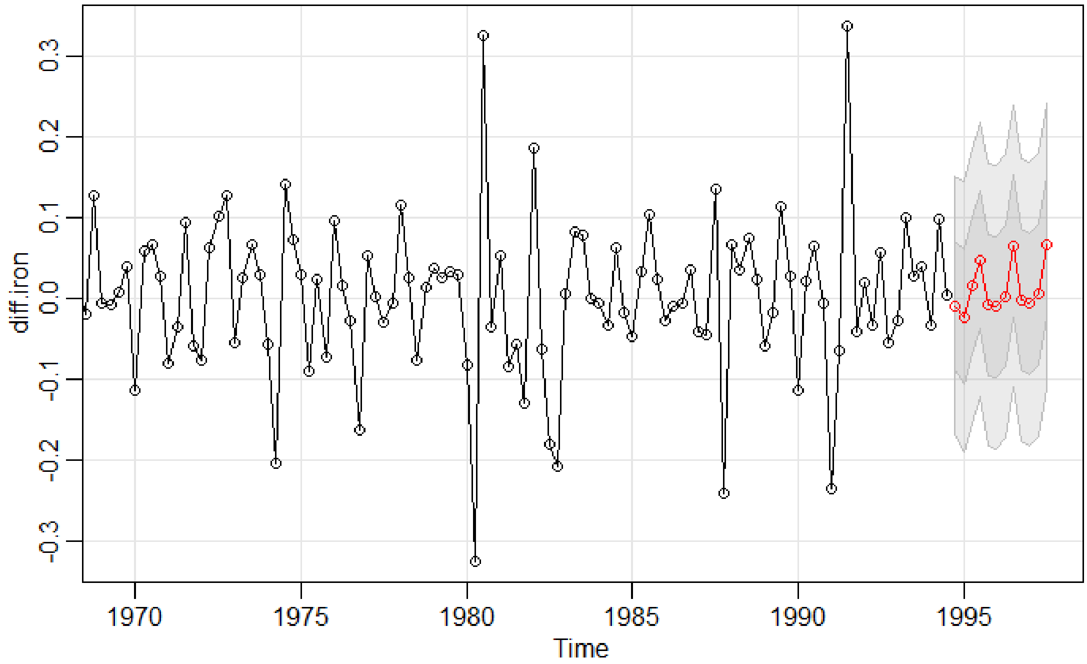

Figure 6

Conclusion

After trying regression model and many SARIMA models, I finally constructed the proper SARIMA model SARIMA (1,1,2,0,1,2). We can use model to predict the iron production in Australia after 1990. And the result reflects the economics of Australia in some aspects. From the prediction result, the iron production will increase after 1990. But unfortunately I can’t find the data after 1990 to check if the prediction is right.

R code Appendix:

```
iron.ts<- ts(head(basic_quarterly_iron_production$`Basic quarterly iron production in Australia: thousand tonnes. Mar 1956 ? Sep 1994`,-1), frequency=4, start=c(1956,1))

plot(iron.ts)

log.iron <- log(iron.ts)

c <- rep(1:4,39)

quarter<- head(c,-1)

time.iron = time(log.iron)

time.iron2 = time(log.iron)^2

fit <- lm(log.iron ~ time.iron + time.iron2 + factor(quarter))

summary(fit)

plot(fit)

plot(diff(log.iron))

acf2(diff.iron, max.lag=36)

library(astsa)

diff.iron<- diff(log.iron)

sarima(diff.iron,1,1,2,0,1,2,4)

sarima.for(diff.iron,12,1,1,2,0,1,2,4)
```