Time series student project :

The average weekly exchange rate of TWD/JPY analysis

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Introduction

Japan is one of the famous tourist attraction in Asia. The exchange rate of TWD/JPY declined recently, because of the Bank of Japan announce more quantitative easing. For me, is it a good time to travel to japan depends on the level of the exchange rate. Therefore, I want to know are there some models can be used to describe the exchange rate, and forecast the exchange rate in next 5 months.

In this project, we will first check time series data, then build ARIMA model to fit the data and test the goodness of fit of model. Final, we will forecast the exchange rate of TWD/JPY in next 20 weeks.

Data

This student project use the average weekly exchange rate data(TWD/JPY) between 2011 ~ 2014. The Original data is daily exchange rate series, but I exchange the data to average weekly rate for simplicity, data source come from this website:

https://www.skbank.com.tw/RAT/RAT2_Historys.aspx

Figure 1. The average weekly exchange rate of TWD/JPY between 2011~2014

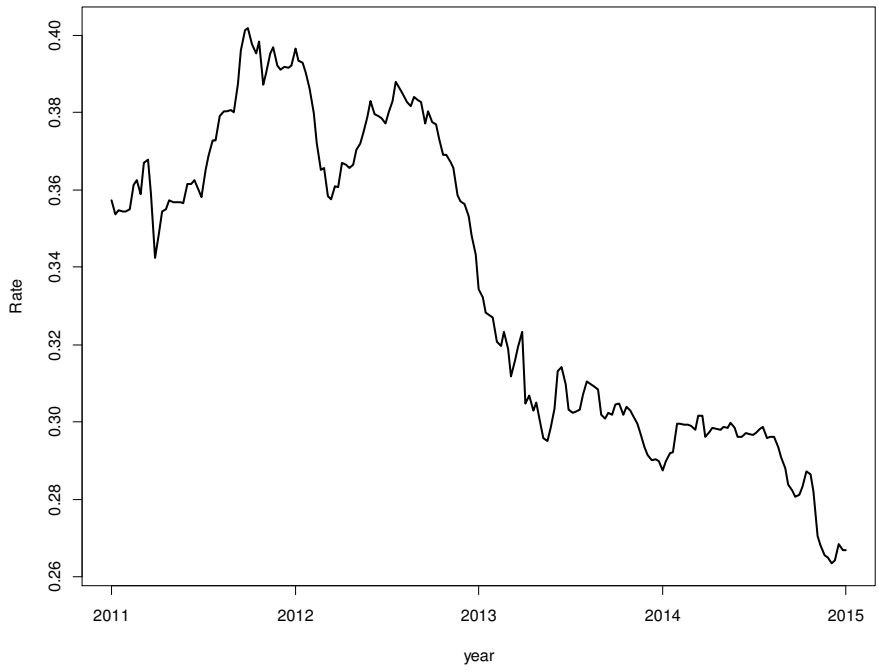
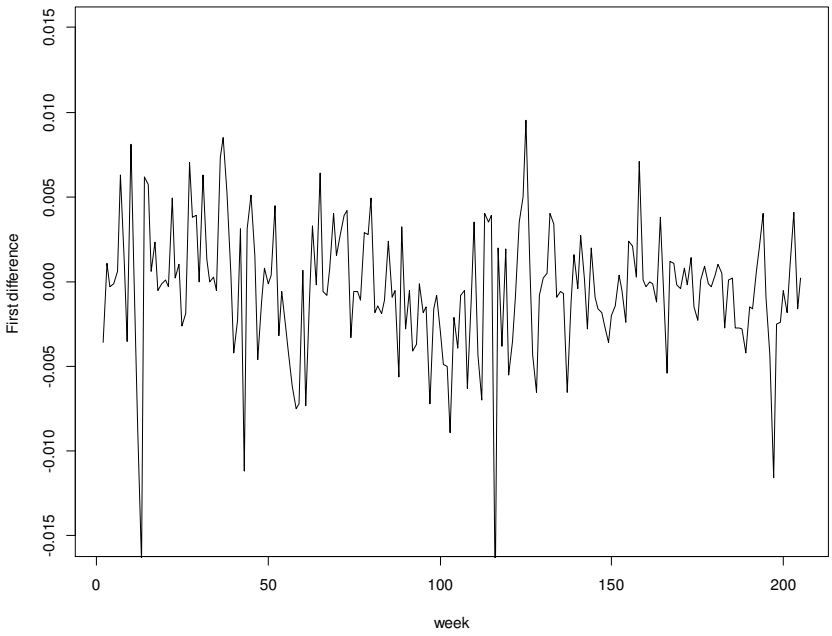


Figure 1 display the series exchange rate data for 1 Yen to New Taiwan Dollar between 2011~2014. This series data display considerable variation in 2012 and 2013. The variation increase when time

increase also show that this is not a stationary series.

So we use difference to manipulate the series and show in Figure 2.

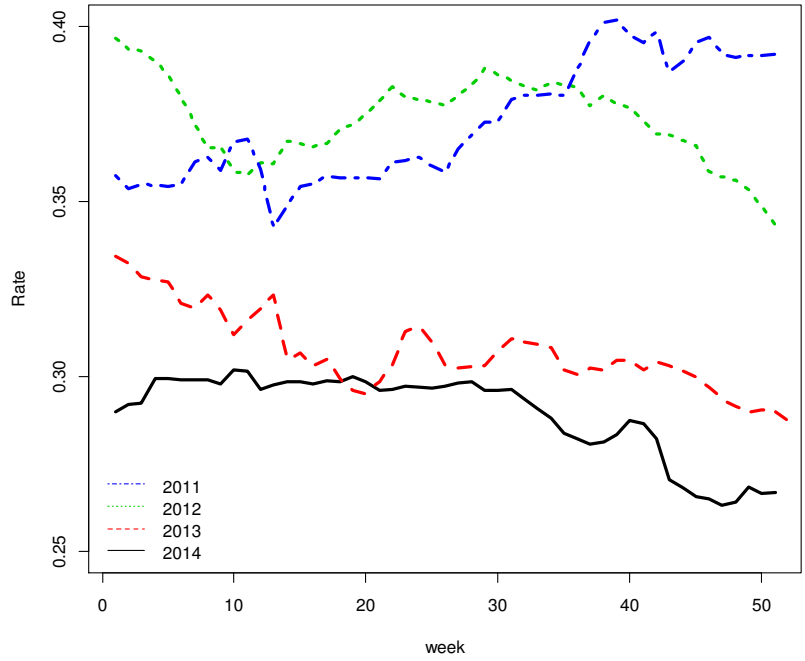
Figure 2. First Difference average weekly exchange rate of TWD/JPY between 2011~2014



In figure 2 we can see the random fluctuations in the data are roughly constant in size over time.

Now, we will check the seasonality. Figure 3 display the average weekly exchange rate TWD/JPY between 2011 and 2014. Four curves do not have the same pattern across weeks, which indicate the exchange rate data does not have seasonal effect. Therefore, we don`t need to consider the seasonal effect in model.

Figure 3. The average weekly exchange rate of TWD/JPY between 2011~2014



Model Specification

We will use ARIMA(p,1,q) model to fit the first difference series data, the first step is to choose the appropriate values for p, q. In Figure 4 shows that the sample autocorrelation at some lag number will exceed the significance bounds. However, this may be due to chance. In Figure 4 autocorrelation and Figure 5 partial autocorrelation indicate that we can consider ARI(1,1) model.

Figure 4. Sample ACF for First Difference average weekly exchange rate of TWD/JPY between 2011~2014

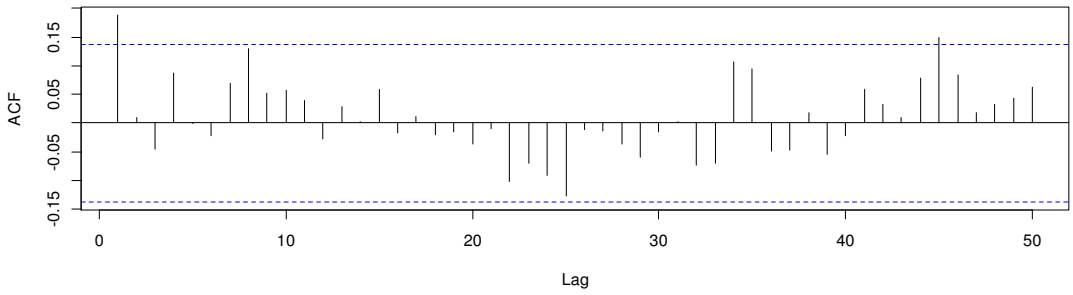
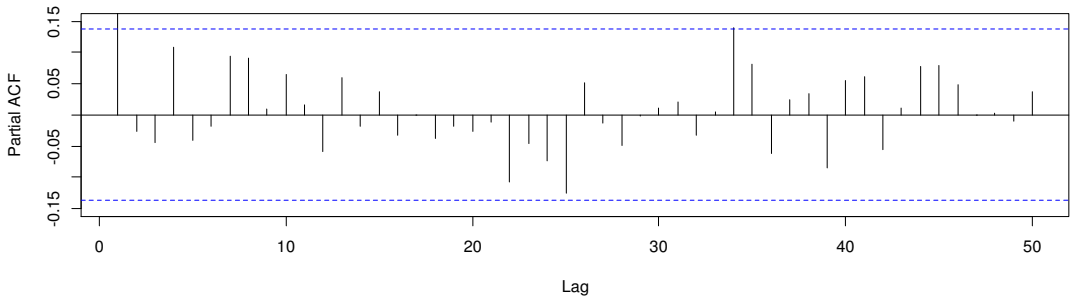
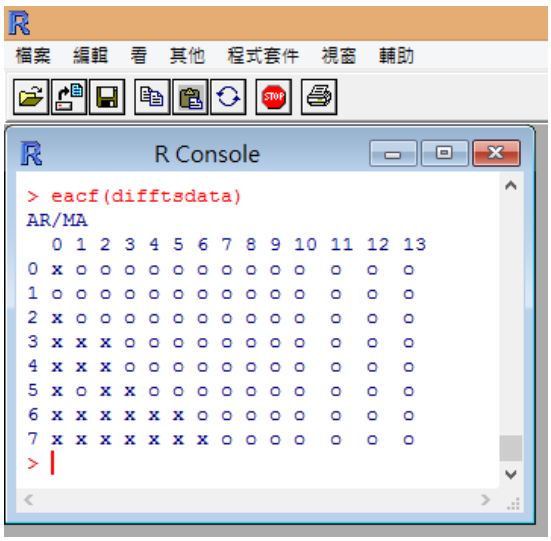


Figure 5. Sample PACF for First Difference average weekly exchange rate of TWD/JPY between 2011~2014



And we can use the extended autocorrelation(EACF) to identify the ARIMA orders.

Figure 6. The result of EACF in R



Based on Figure 4~6 and the principle ***models should be simple, but not too simple***, I consider fitting ARI(1,1) model.

Model fitting

Since the order of ARIMA(p,d,q) model has been specified, we can use the function "arima(data, order=c(p,d,q))" in R to estimate the parameters. And because of the mean of first difference series data is -0.0004431373, we will consider the constant term in ARI(1,1) model.

The model fitting result in R are showing below:

```
> fit1 = arima(tsdata,order=c(1,1,0),xreg=1:datalen)
> fit1
Series: x
ARIMA(1,1,0)
Coefficients:
          ar1      xreg
       0.1885    -4e-04
s.e.   0.0688     3e-04
sigma^2 estimated as 1.456e-05:  log likelihood=842.84
AIC=-1681.69   AICc=-1681.57   BIC=-1671.73
```

The formula of ARI(1,1) :

$$W_t = -0.0004 + 0.1885 W_{t-1} + e_t \quad ; \quad W_t = Y_t - Y_{t-1} \quad \text{for} \quad t \geq 1$$

Diagnostic Checking

We have built ARI(1,1) model and estimated parameters. Now, model diagnostics is concerned with testing the goodness of fit of a model, we will analyze the residuals from the fit for any signs of non–randomness.

First, we check the normality of residuals.

Figure 7. Standardized Residuals from ARI(1,1) model

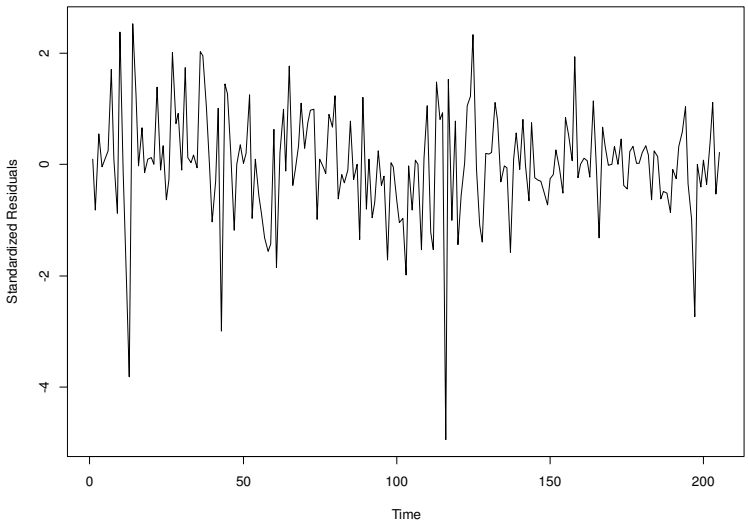


Figure 8. The Quantile-Quantile-plot: Residuals from ARI(1,1) for Exchange rate

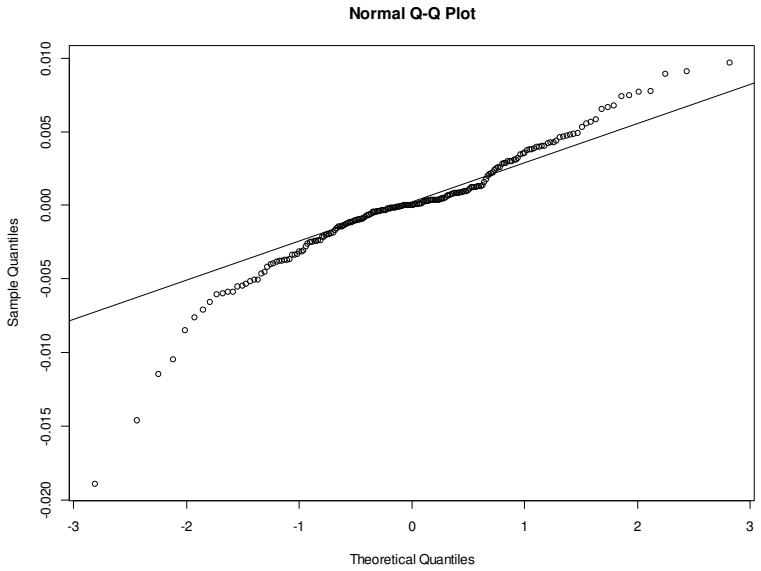


Figure 7 and Figure 8 shows the series data not with a good normality, and I also use Shapiro-Wilk normality test in R.

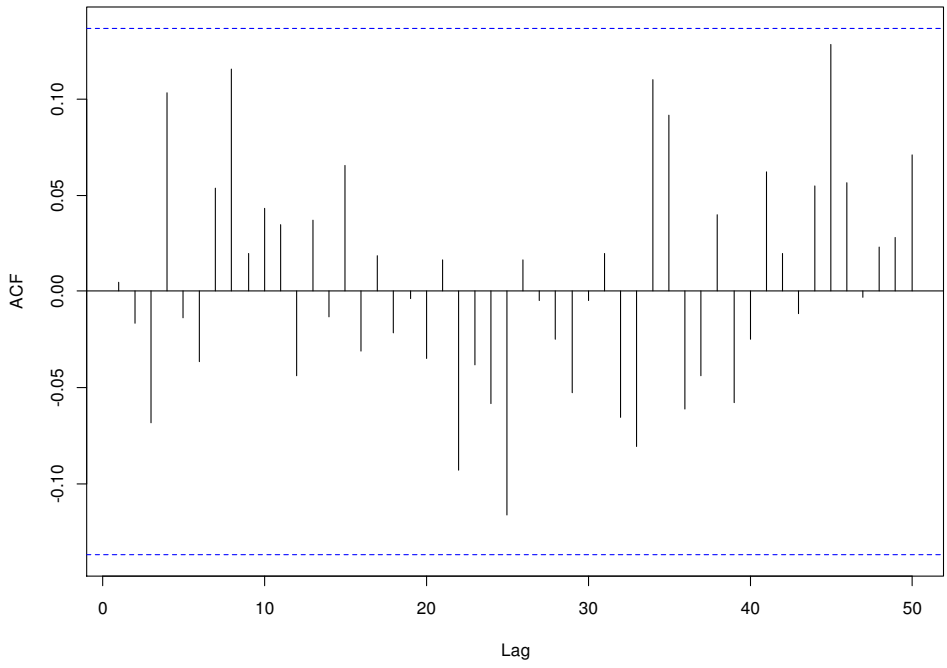
```
> shapiro.test(residuals(fit1))

        Shapiro-Wilk normality test

data:  residuals(fit1)
W = 0.9417, p-value = 2.434e-07
```

Next, we check the independence of noise term in the model.

Figure 9. Sample ACF of Residuals from ARI(1,1) model



And, I also use the Ljung–Box test to examines the null of independently distributed residuals, the result shown that we have no evidence to reject the null hypothesis that the error terms are uncorrelated.

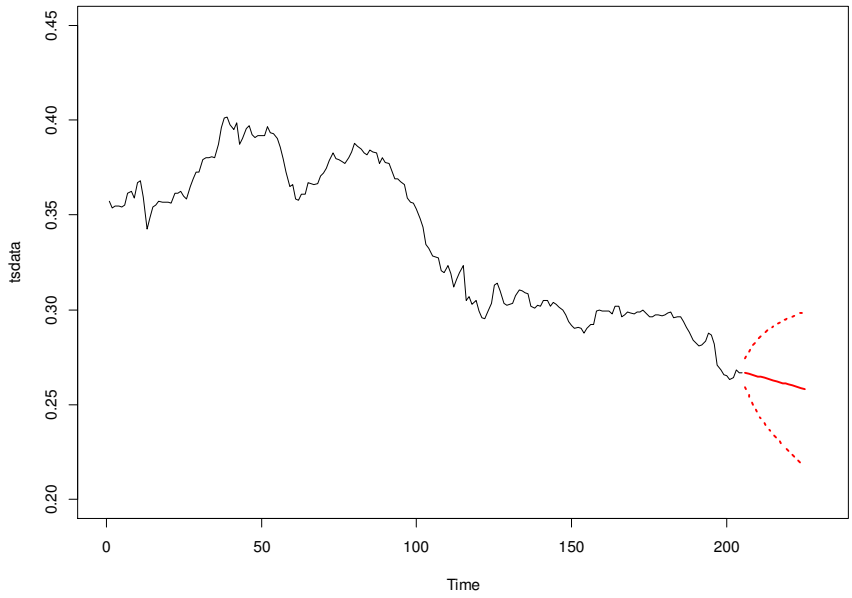
```
> Box.test(residuals(fit1),lag=50,type="Ljung-Box")
        Box-Ljung test

data:  residuals(fit1)
X-squared = 37.1874, df = 50, p-value = 0.9103
```

Forecasting

Figure 10 displays the last 4 years of the average weekly exchange rate of TWD\JPY time series with forecasts and 95% forecast limits for 20 additional weeks.

Figure 10. Forcast from ARI(1,1) model for average weekly exchange rate of TWD/JPY



Conclusion

Base on above analysis, we use ARI(1,1) model to forecast the average weekly exchange rate in next 20 weeks, the result in Figure 10 shown that the exchange rate will decrease in next 20 weeks. Therefore, I will not exchange new Taiwan dollar to Yen too early.