Analysis of Currency Exchange Rate by Using Time Series

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Exchange Rate of Canadian Dollar to Chinese Yuan

```
library("quantmod")
```

```
## Loading required package: xts
```

```
## Loading required package: zoo
```

```
##
## Attaching package: 'zoo'
```

```
## The following objects are masked from 'package:base':
##
##     as.Date, as.Date.numeric
```

```
## Loading required package: TTR
```

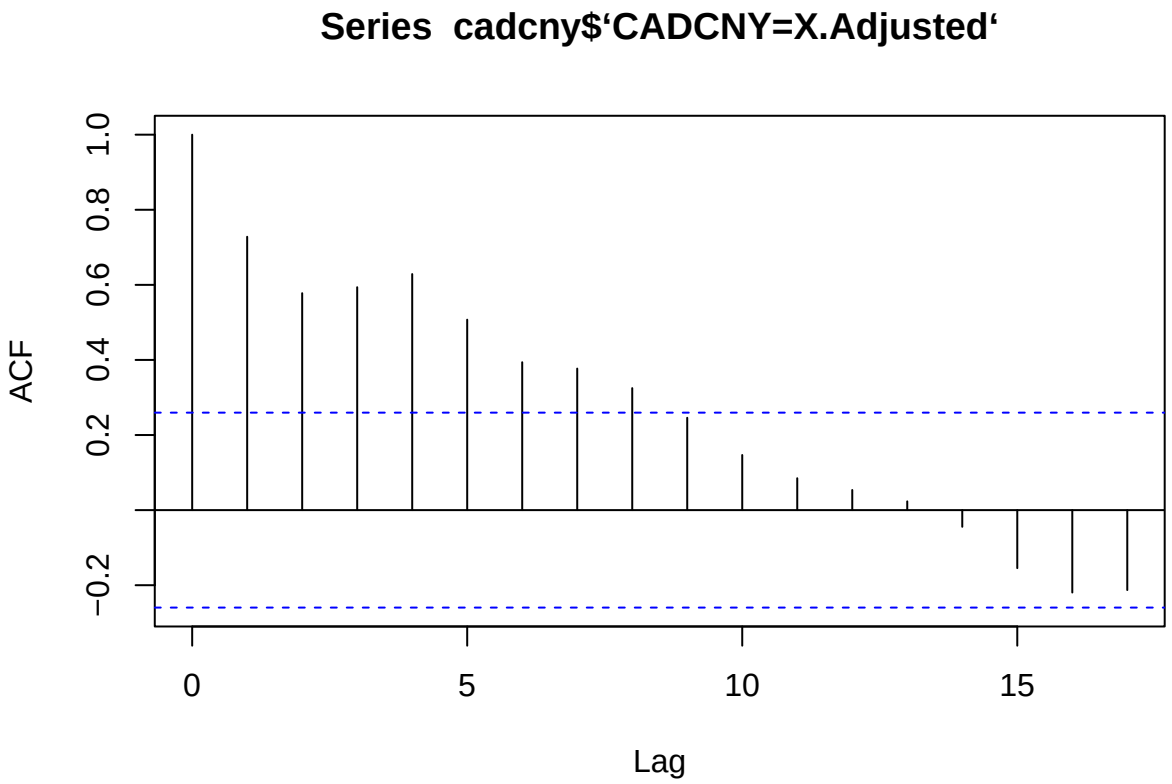
```
## Registered S3 method overwritten by 'quantmod':
##   method            from
##   as.zoo.data.frame zoo
```

```
library("forecast")
library("astsa")
```

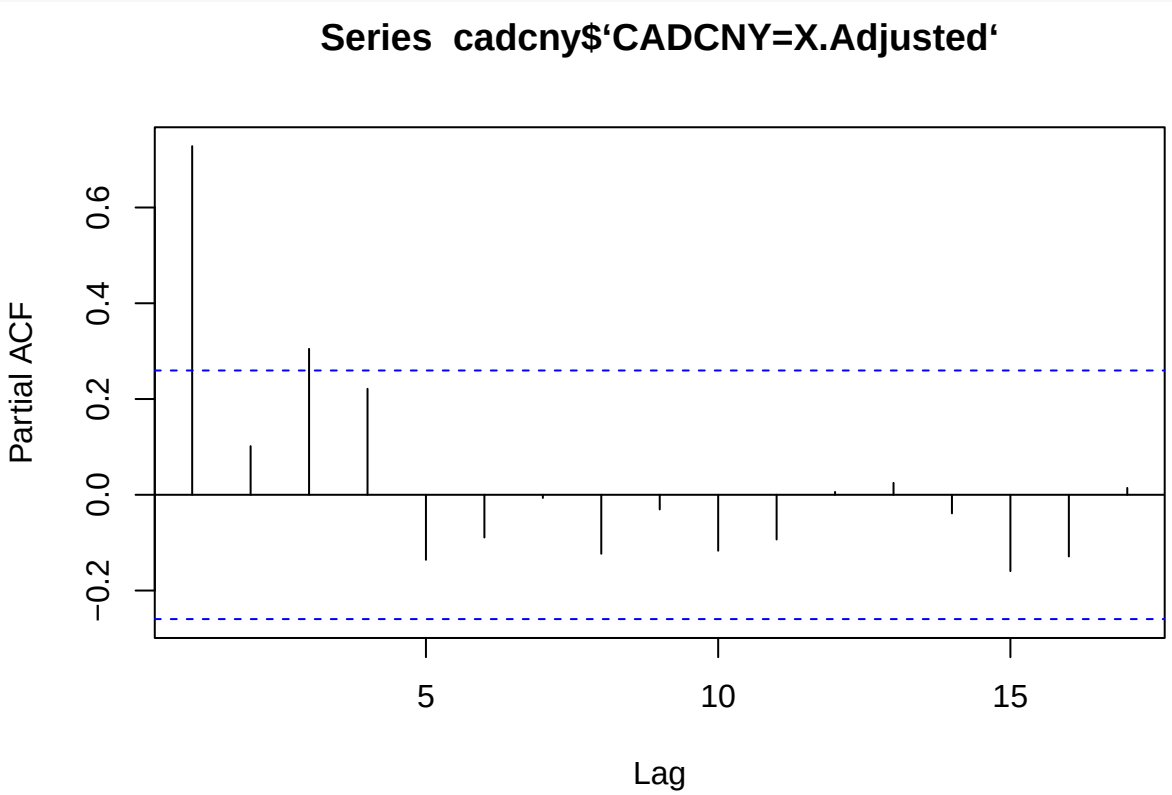
```
##
## Attaching package: 'astsa'
```

```
## The following object is masked from 'package:forecast':
##
##     gas
```

```
#Use na.omit to remove missing data
cadcny <- na.omit(getSymbols("CADCNY=X",src="yahoo",auto.assign = FALSE,from = "2022-09-01",to = "2022-
acf(cadcny$`CADCNY=X.Adjusted`)
```




```
pacf(cadcny$`CADCNY=X.Adjusted`)
```



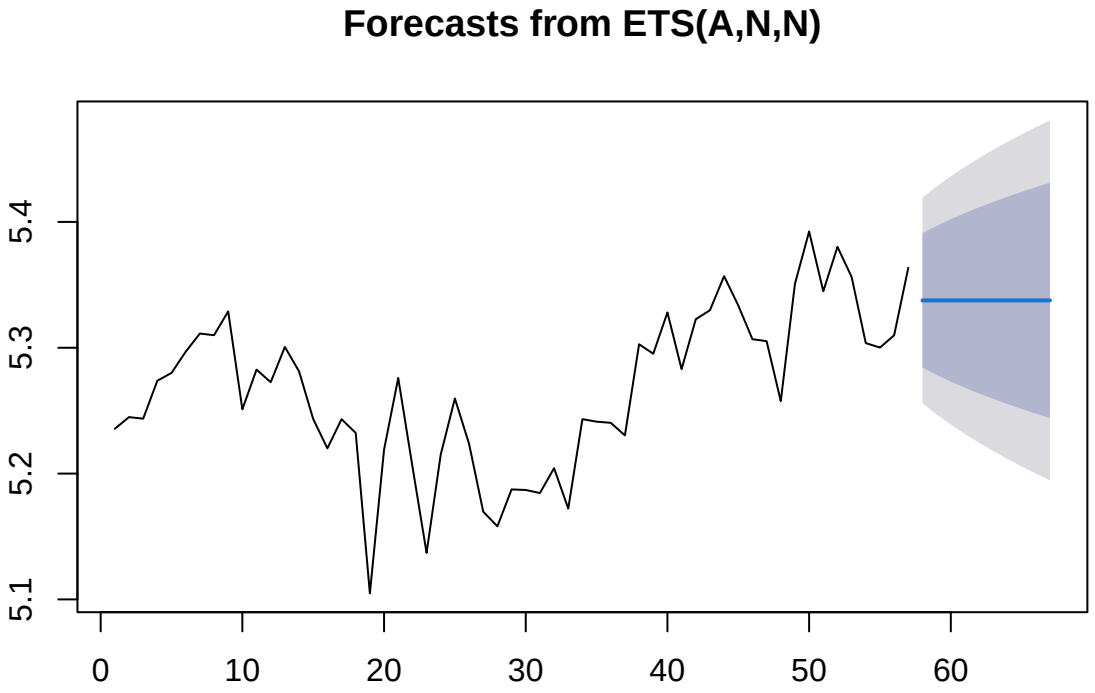

```
auto.arima(cadcny$`CADCNY=X.Adjusted`)
```

```
## Series: cadcny$`CADCNY=X.Adjusted`
```

```
## ARIMA(0,1,2)
##
## Coefficients:
##           ma1      ma2
##       -0.3215  -0.2375
## s.e.   0.1300   0.1183
##
## sigma^2 = 0.001669:  log likelihood = 100.49
## AIC=-194.99   AICc=-194.52   BIC=-188.91
```

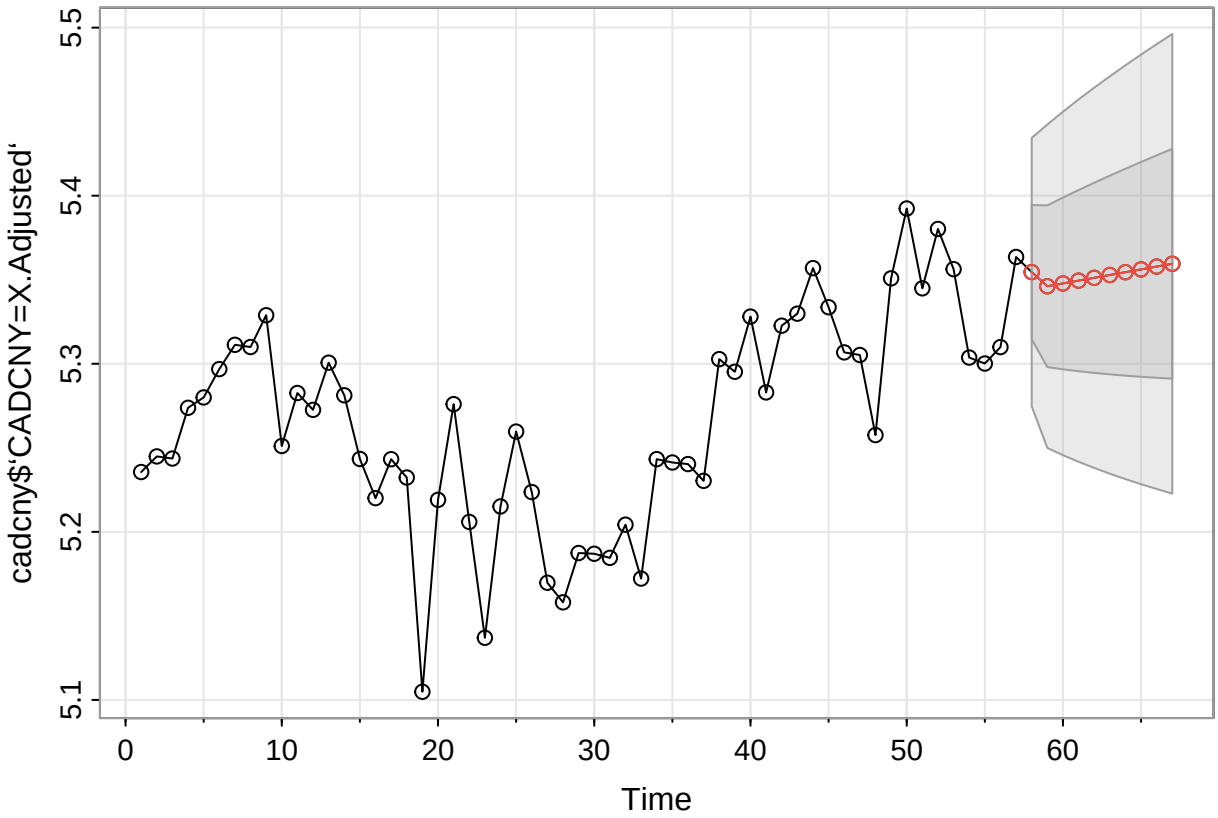
#use ets to fit the model and give out the prediction

```
fitted_model <- ets(cadcny$`CADCNY=X.Adjusted`)
ets.p <- predict(fitted_model,10)
plot(ets.p)
```



#Using auto.arima function and sarima.for given out the prediction.

```
fitted_model <- auto.arima(cadcny$`CADCNY=X.Adjusted`)
arma.p <-sarima.for(cadcny$`CADCNY=X.Adjusted`,10,0,1,2)
```



#The ets is getting almost the same result with auto.arima

$$sMAPE = 100 \times \frac{1}{m} \sum_{i=1} \frac{|F_i - A_i|}{(|A_i| + |F_i|)/2}$$

Analyze model by sMAPE:

```
a_cadcny <- na.omit(getSymbols("CADCNY=X",src="yahoo",auto.assign = FALSE,from = "2022-11-19",to = "2023
a.data <- a_cadcny$`CADCNY=X.Adjusted`[1:10]
sMAPE <- function(x,y){  2 * 100 * mean( abs(x-y) / (abs(x)+abs(y))) }
ets.sMAPE <- sMAPE(ets.p$mean,a.data)
```

```
## Warning in mean(abs(x - y)/(abs(x) + abs(y))): Incompatible methods ("Ops.ts",
## "Ops.xts") for "-"
```

```
## Warning in mean(abs(x - y)/(abs(x) + abs(y))): Incompatible methods ("Ops.ts",
## "Ops.xts") for "+"
```

```
arma.sMAPE <- sMAPE(arma.p$pred,a.data)
```

```
## Warning in mean(abs(x - y)/(abs(x) + abs(y))): Incompatible methods ("Ops.ts",
## "Ops.xts") for "-"

## Warning in mean(abs(x - y)/(abs(x) + abs(y))): Incompatible methods ("Ops.ts",
## "Ops.xts") for "+"
```

```
ets.sMAPE
```

```
## [1] 0.6160527
```

```
arma.sMAPE
```

```
## [1] 0.7747836
```

$$ets.sMAPE = 0.6160527 < 0.7747836 = arma.sMAPE$$

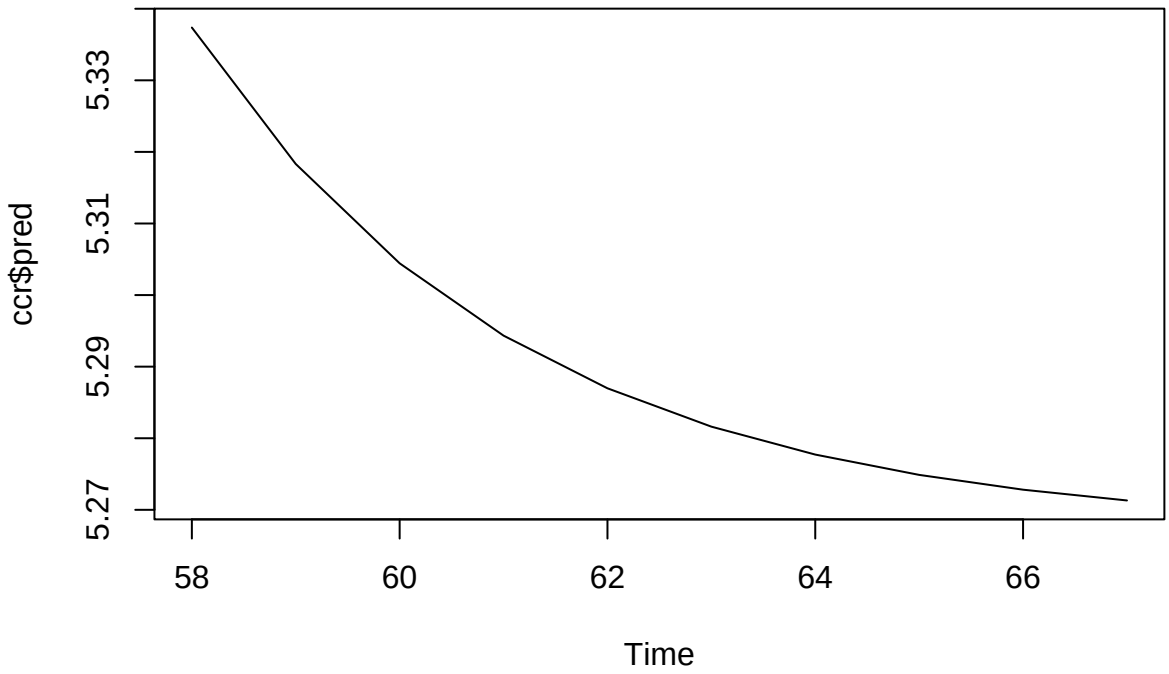
So ets model has more accurate prediction than that of ARIMA(0,1,2)

#Try another model called Yule-Walker Estimation. #choose AR(1) model and use Yule-Walker Estimation

```
x <- ar.yw(cadcny$`CADCNY=X.Adjusted`,order = 1)
x
```

```
##
## Call:
## ar.yw.default(x = cadcny$`CADCNY=X.Adjusted`, order.max = 1)
##
## Coefficients:
##      1
## 0.7281
##
## Order selected 1  sigma^2 estimated as  0.001881
```

```
ccr <- predict(x,n.ahead = 10)
plot(ccr$pred)
```



By using Yule-Walker Estimation,

$$X_t = 0.6994Y_{t-1} + 0.2023Y_{t-2} + 0.0968Y_{t-3} + W_t$$

where

$$Y_t = X_t - \hat{\mu},\ \hat{\mu} = 5.870677,\ \hat{\sigma}^2 = 0.002558912$$

Conclusion: Yule-Walker model is limited. In this specific situation, ets model performed better prediction than ARIMA(0,1,2). However, these model do predict the same decreasing trend which is consist with the accrual trend.