Question 2:

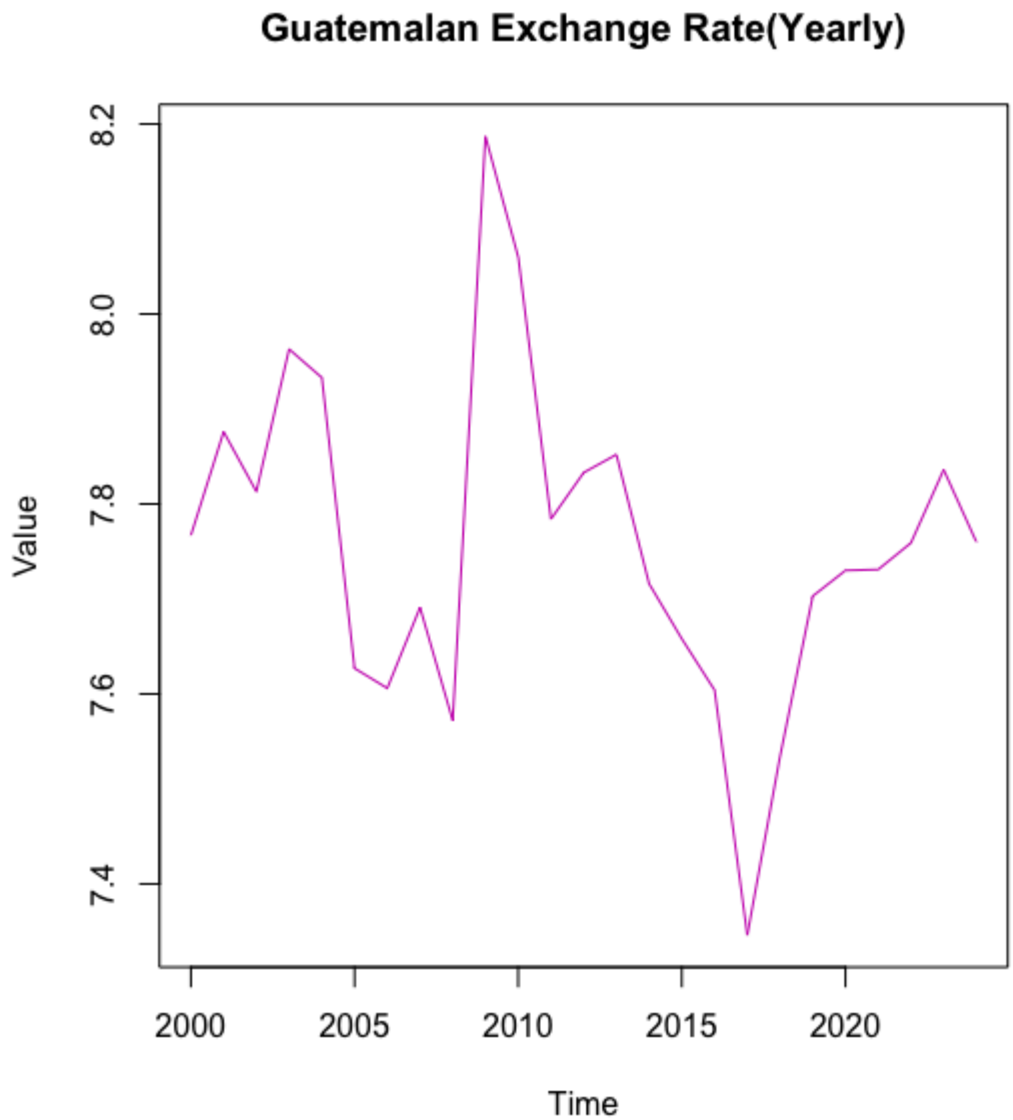
b)

The dataset I chose is the US dollar exchange rate for the Guatemalan Quetzal from 2000 to 2024. As a Guatemalan from a Guatemalan household, I find this dataset fun and personal to analyze. Growing up and still currently, my parents frequently sent money to our family back in Guatemala. I noticed that the exchange rate on the receipt was mostly always around the same amount over the years. Therefore, I want to explore and analyze the trends of this exchange rate in greater detail and find the factors that contribute to the fluctuations. Additionally, this could be important information since I expect to send money to my parents once they decide to return to Guatemala.

c)

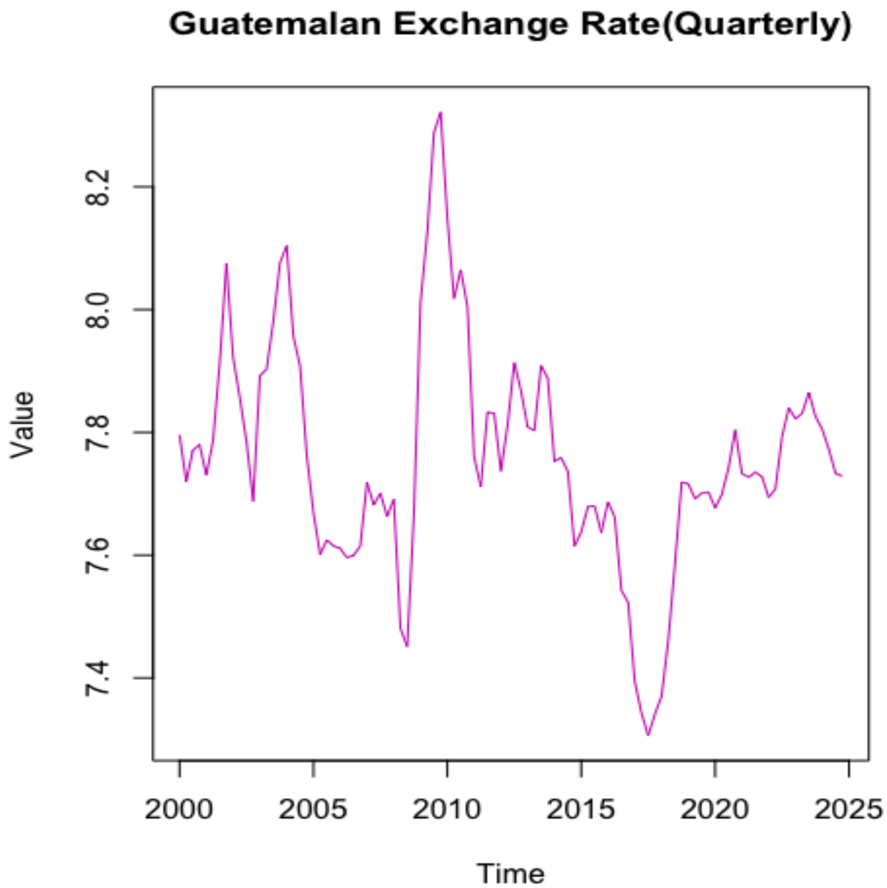
I collected the data on the BIS Data Portal website and focused on data starting from 2000, as I felt it would be more relevant to today's market trends and to the time I've seen my parents send money. After downloading the dataset into an Excel sheet, the data was formatted monthly so to simplify it, I converted it to a quarterly dataset by calculating the average exchange rate for each quarter. Similarly, to create a yearly dataset, I calculated the average of the quarterly values for each year.

```
head(Rate,n=12)
  Year_Quarter Value
1      2000 Q1 7.796
2      2000 Q2 7.720
3      2000 Q3 7.771
4      2000 Q4 7.780
5      2001 Q1 7.730
6      2001 Q2 7.786
7      2001 Q3 7.912
8      2001 Q4 8.075
9      2002 Q1 7.922
10     2002 Q2 7.857
11     2002 Q3 7.785
12     2002 Q4 7.688
```

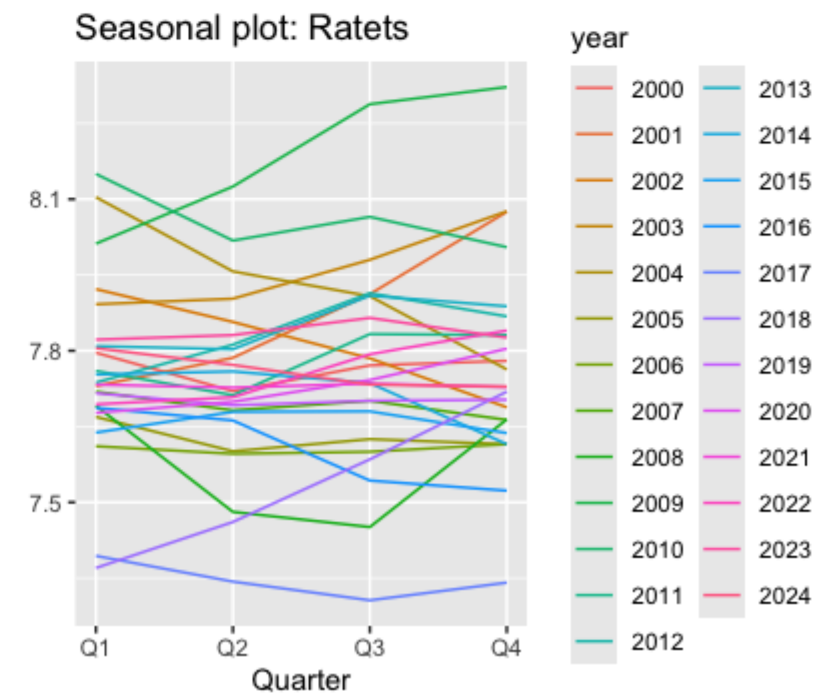


d)

The plot suggests no long-term trend but constant fluctuations throughout the period. We see the volatility in the first decade with constant increases and decreases, however, the most significant spike around 2009-2010, where it reached its highest. This could have been due to the global financial crisis of 2008. Following 2010, there was a steady decline until 2016, the lowest point which could be the aftermath of the stabilization of the Quetzal following the global financial crisis. In more recent years, from 2020 to now, the value has stabilized with no major fluctuations. The plot shows that the exchange rate has constant fluctuations but remains stable within the range of 7.6 and 8 GTQ per USD.



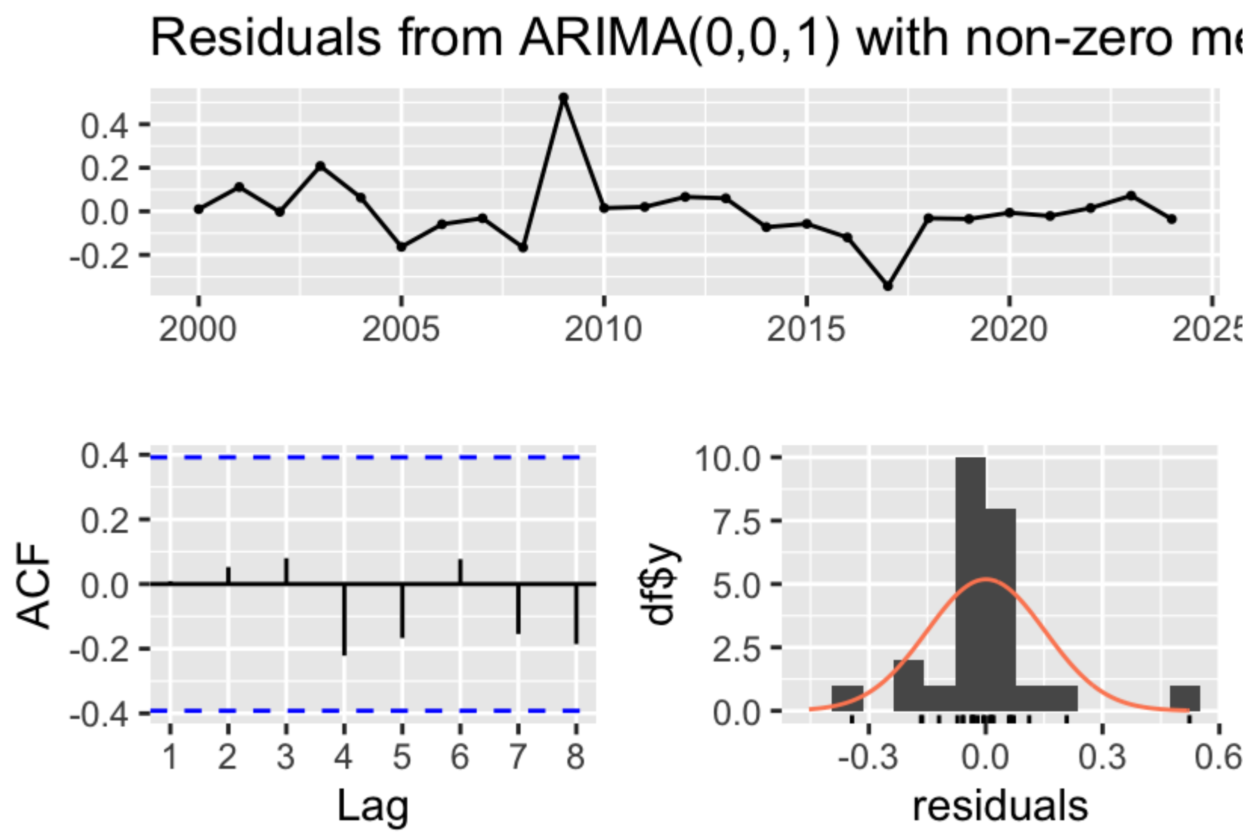
The quarterly plot shows smaller fluctuations throughout the period than the yearly plot, however, many of the points remain the same. The plot suggests that there is no long-term trend and plenty of volatility. Compared to the yearly plot, the quarterly plot indicates that in more recent times, the Quetzal has had plenty of increase and decrease fluctuations which could indicate the uncertainty of the market after COVID.



Additionally, through this plot we can see a lot of overlap between the years, proving the lack of trend and no clear seasonality present.

Models for Annual Data:

ARIMA MODEL:



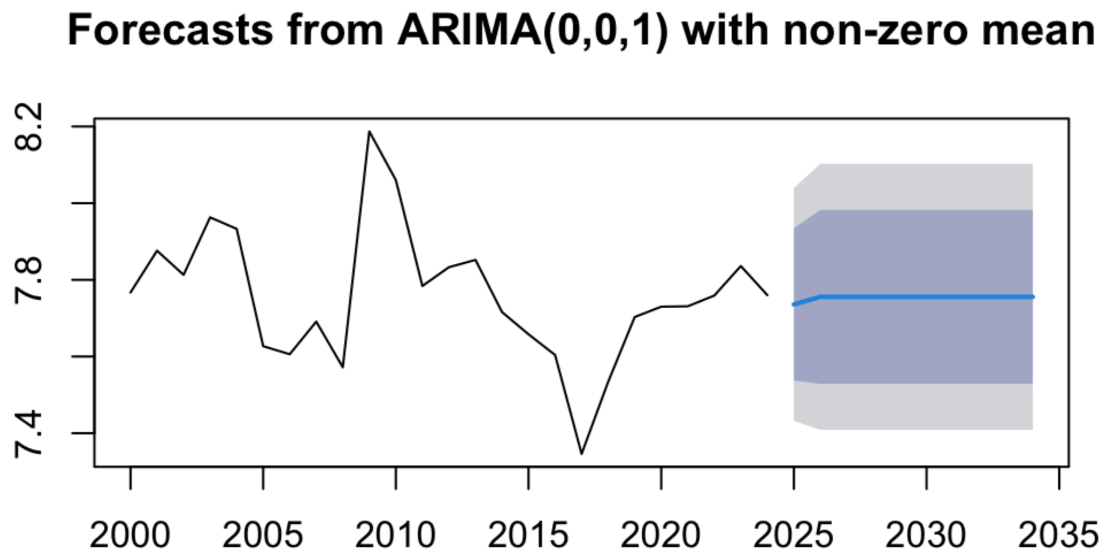
Ljung-Box test

data: Residuals from ARIMA(0,0,1) with non-zero mean

Q* = 2.7972, df = 4, p-value = 0.5923

Model df: 1. Total lags used: 5

Ho: No autocorrelation, H1: There is autocorrelation. Since the p-value is greater than 5%, we fail to reject Ho, therefore the residuals have no autocorrelation. The residuals are centered at zero with no increase or decay in variance and the data distribution appears normal although more data could be useful. So I conclude that this is a good model.

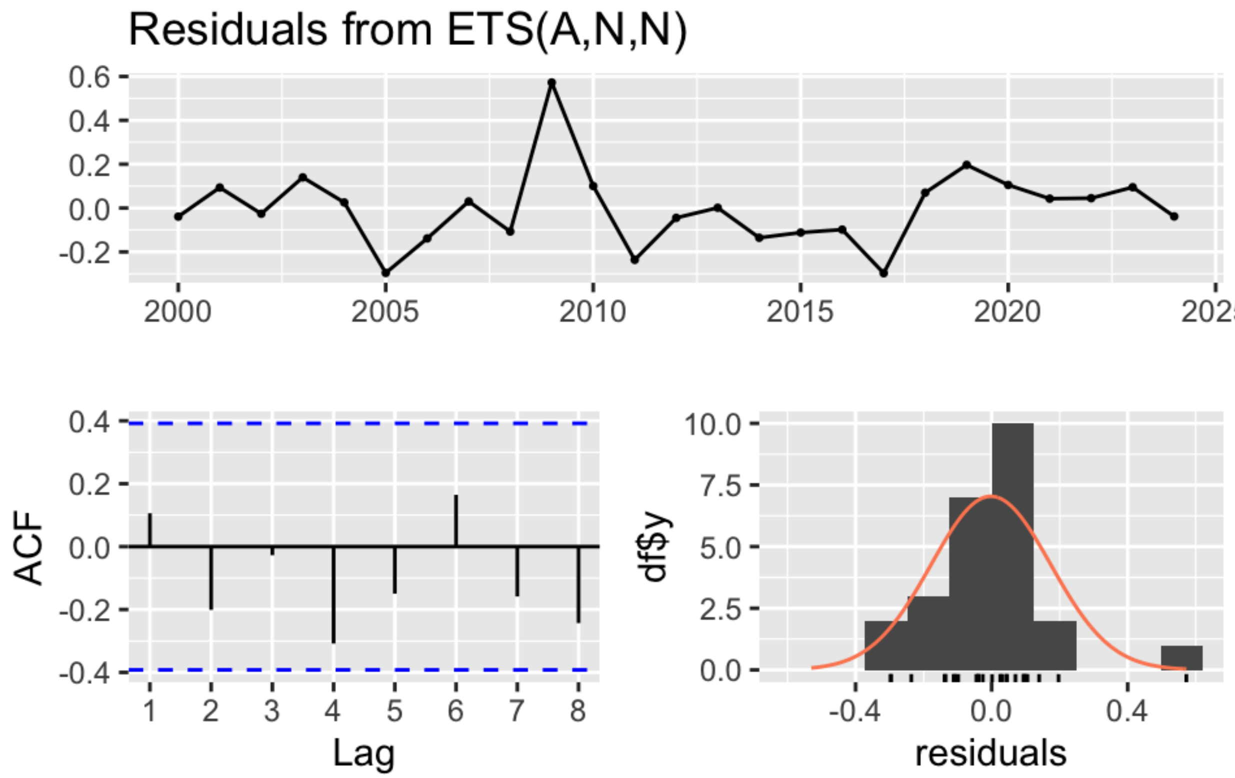


Forecast values for the next 5 years for this model are:

	Point Forecast	Lo 80	Hi 80	Lo 95	Hi 95
2025	7.736002	7.537639	7.934365	7.432632	8.039371
2026	7.755622	7.528930	7.982314	7.408926	8.102318
2027	7.755622	7.528930	7.982314	7.408926	8.102318
2028	7.755622	7.528930	7.982314	7.408926	8.102318
2029	7.755622	7.528930	7.982314	7.408926	8.102318

I chose the ARIMA model to forecast the next 5 years because I believe that the confidence intervals are the best and like the range.

ETS MODEL:



Ljung-Box test

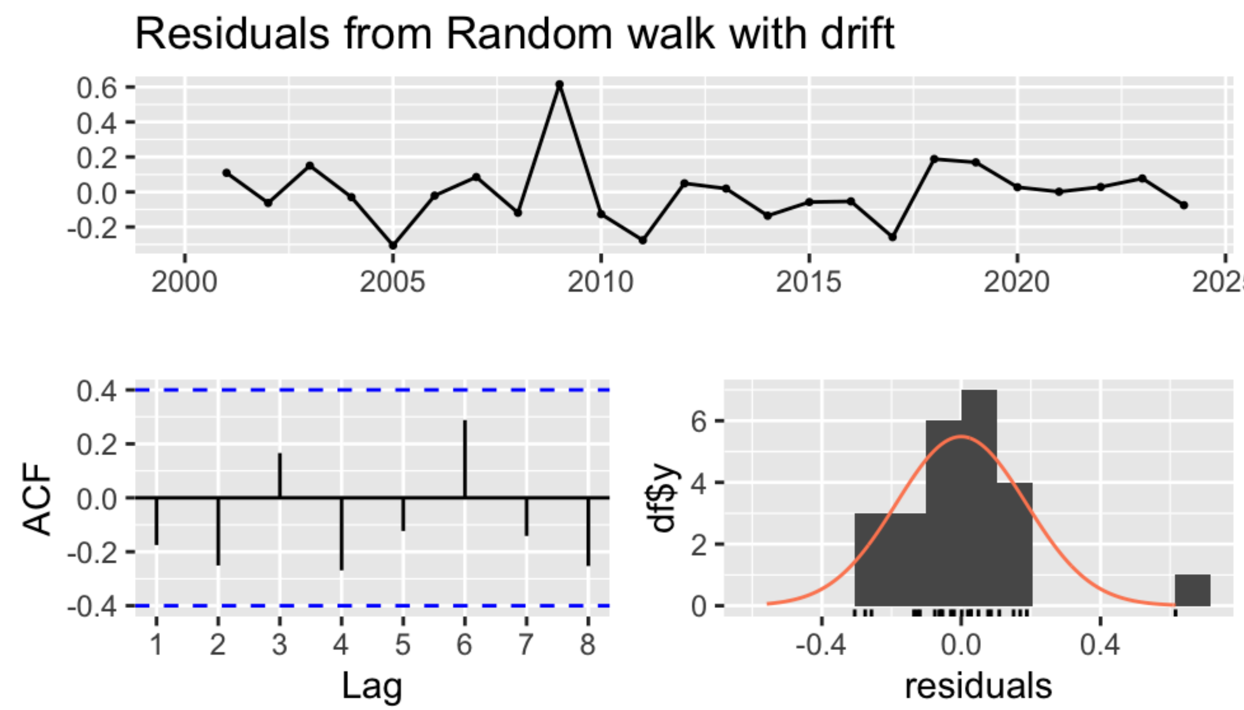
data: Residuals from ETS(A,N,N)

Q* = 5.3311, df = 5, p-value = 0.3768

Model df: 0.   Total lags used: 5

Ho: There is no autocorrelation, H1: There is autocorrelation. Since the value is greater than 5%, we fail to reject Ho therefore the residuals are not correlated. The residuals are centered at zero with no clear growth or decay in variance. The data distribution appears to be normal but more data could be useful. So I conclude that this is a good model.

RWF MODEL:



Ljung-Box test

data: Residuals from Random walk with drift

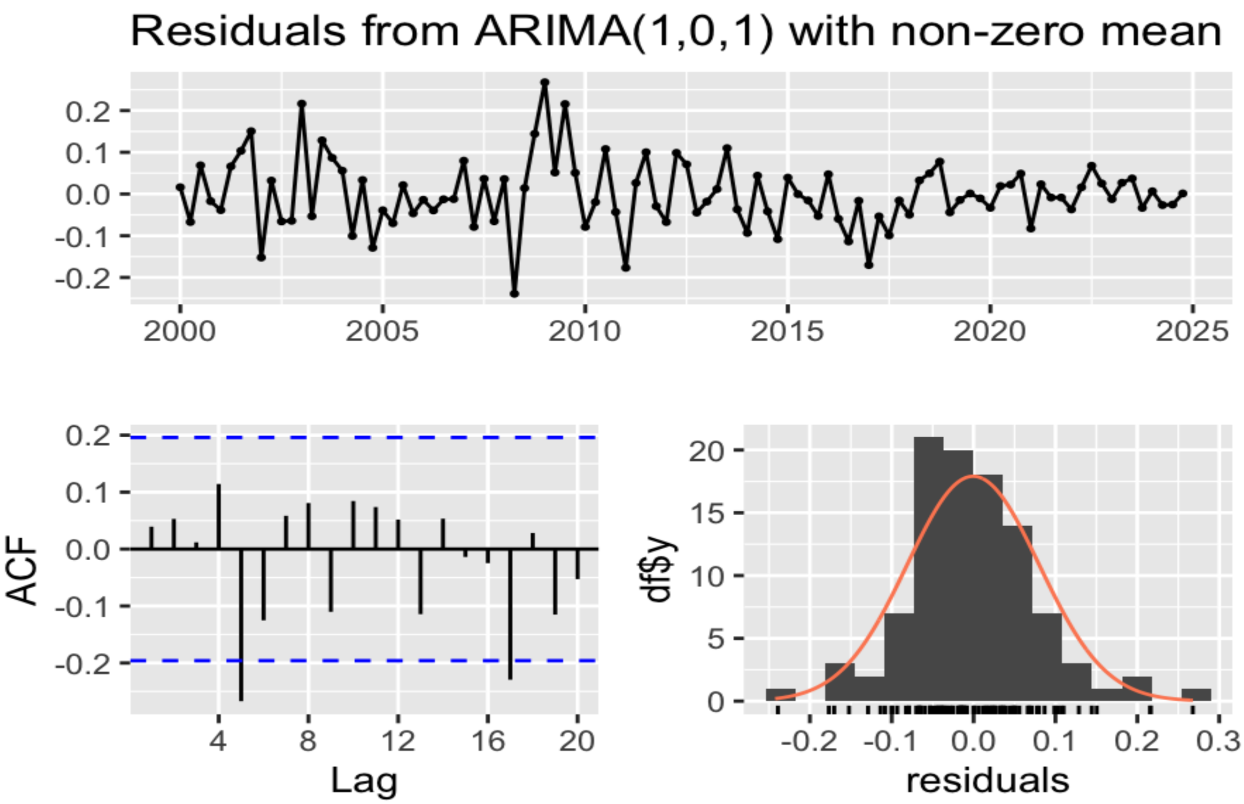
Q* = 6.1818, df = 5, p-value = 0.2889

Model df: 0.   Total lags used: 5

Ho: There is no autocorrelation, H1: There is autocorrelation. Since our p-value is greater 5%, we fail to reject Ho therefore the residuals are not correlated. The residuals are centered at zero with no clear growth or decay in variance. The data distribution appears to be normal although more data could be useful. So I conclude that this is a good model.

Models for Quarterly Data:

Arima Model:



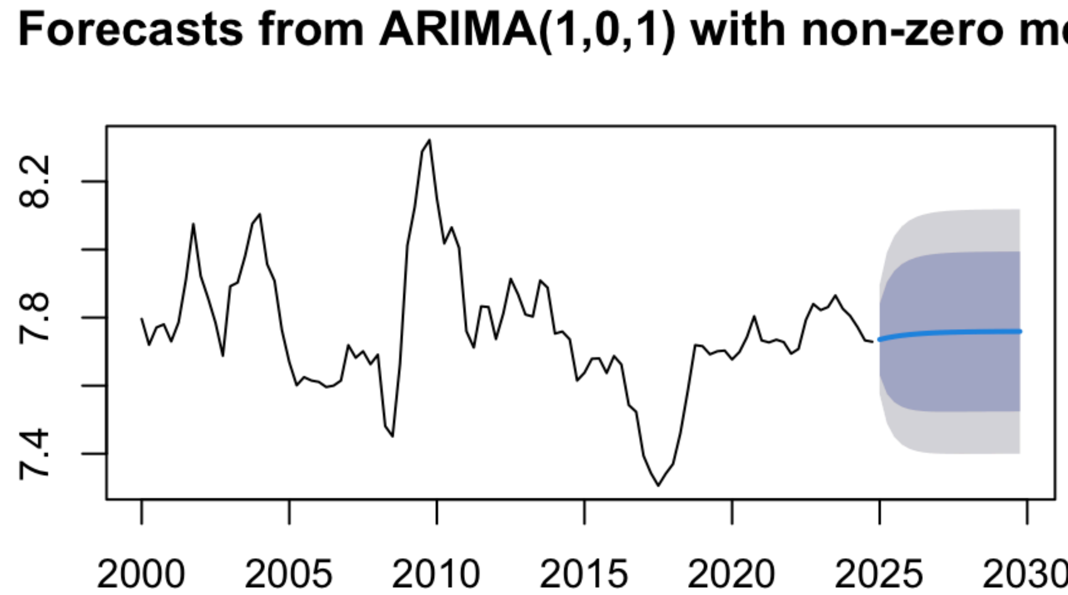
Ljung-Box test

data: Residuals from ARIMA(1,0,1) with non-zero mean

Q* = 12.306, df = 6, p-value = 0.05547

Model df: 2. Total lags used: 8

Ho: There is no autocorrelation, H1: There is autocorrelation. Since the p-value is greater than 5% we fail to reject Ho, therefore the residuals are not correlated. The residuals are centered at zero with no clear growth or decay in variance. The data distribution appears normal, and the ACF plot only has two values that pass the confidence interval. Concluding, this is a good model although it falls within the gray area.

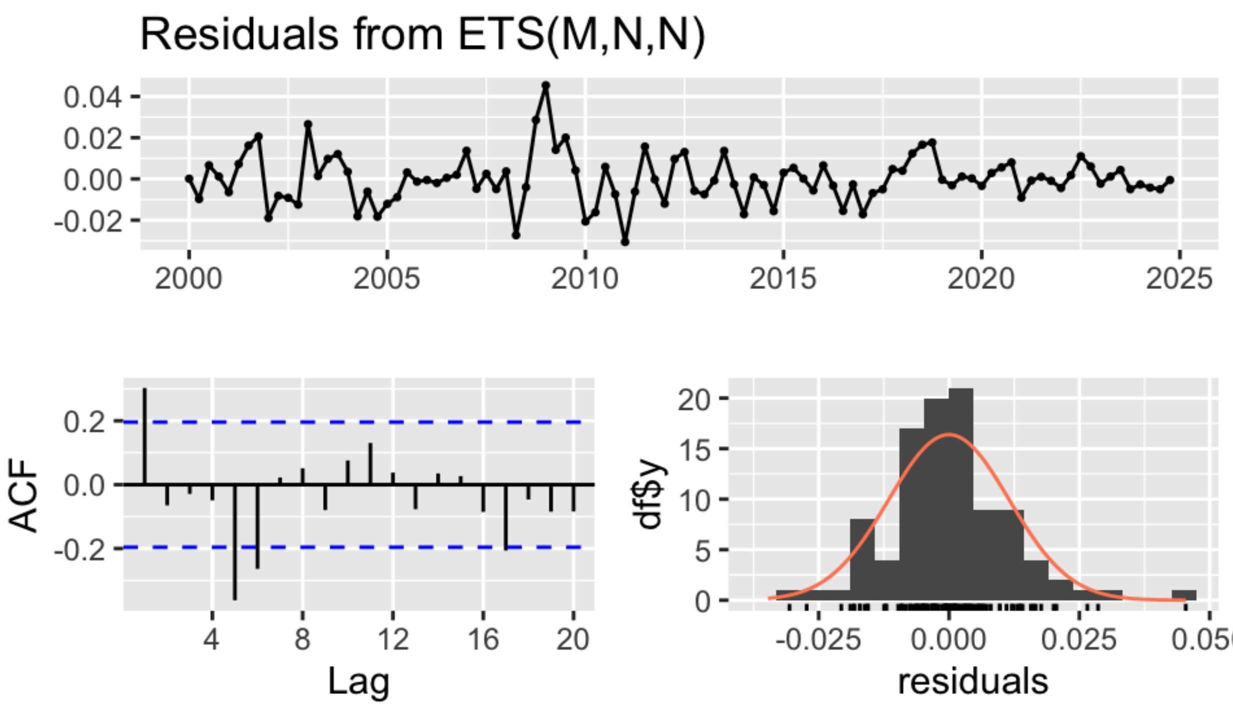


Forecasts for the next 5 years are:

	Point Forecast	Lo 80	Hi 80	Lo 95	Hi 95
2025 Q1	7.735743	7.631335	7.840151	7.576065	7.895421
2025 Q2	7.740584	7.576071	7.905097	7.488983	7.992185
2025 Q3	7.744440	7.551255	7.937625	7.448990	8.039891
2025 Q4	7.747512	7.538161	7.956863	7.427337	8.067687
2026 Q1	7.749959	7.530968	7.968949	7.415041	8.084876
2026 Q2	7.751908	7.527015	7.976801	7.407963	8.095852
2026 Q3	7.753460	7.524901	7.982020	7.403909	8.103011
2026 Q4	7.754697	7.523842	7.985552	7.401634	8.107760
2027 Q1	7.755682	7.523382	7.987982	7.400410	8.110955
2027 Q2	7.756467	7.523254	7.989679	7.399799	8.113135
2027 Q3	7.757092	7.523302	7.990881	7.399542	8.114642
2027 Q4	7.757590	7.523435	7.991745	7.399481	8.115699
2028 Q1	7.757986	7.523600	7.992373	7.399523	8.116450
2028 Q2	7.758302	7.523769	7.992836	7.399615	8.116990

2028 Q3	7.758554	7.523928	7.993180	7.399724	8.117384
2028 Q4	7.758754	7.524069	7.993440	7.399834	8.117675
2029 Q1	7.758914	7.524191	7.993637	7.399936	8.117892
2029 Q2	7.759041	7.524295	7.993788	7.400027	8.118055
2029 Q3	7.759143	7.524381	7.993904	7.400106	8.118180
2029 Q4	7.759223	7.524452	7.993995	7.400172	8.118275

ETS Model:



Ljung-Box test

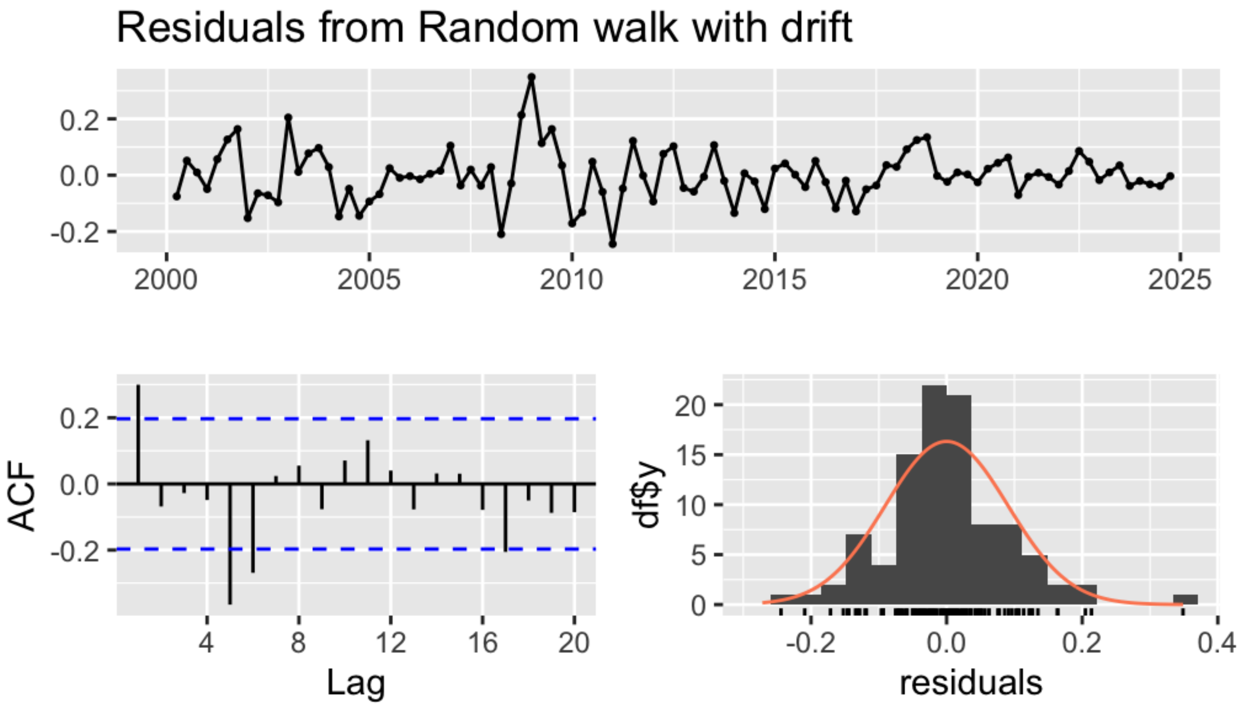
data: Residuals from ETS(M,N,N)

Q* = 32.173, df = 8, p-value = 8.673e-05

Model df: 0. Total lags used: 8

Ho: There is no autocorrelation, H1: There is autorrecaltion. Since the p-value is significantly less than 5%, we reject Ho, therefore the residuals are correlated. The residuals are centered at zero with no clear growth or decay and the data distribution appears normal. However, since the model failed the Ljung-Box test, there are better models than this one.

RWF Model:



Ljung-Box test

data: Residuals from Random walk with drift

Q* = 32.282, df = 8, p-value = 8.291e-05

Model df: 0.   Total lags used: 8

Ho: There is no autocorrelation, H1: There is autocorrelation. Since the p-value is significantly less than 5% we reject Ho, therefore the residuals are correlated. The residuals are centered at zero with no clear growth or decay in variance. The data distribution appears to be normal. However, since the model failed the Ljung-Box test, there are better models than this one.

SUMMARY:

Based on the Guatemalan exchange rate analysis and forecast, the ARIMA model is the best one for both the annual and quarterly forecasts. I chose this model because it passed the Ljung-Box Test and all other checks, even though the results fall slightly within the gray area for the quarterly model. This means that the model works but could require a re-evaluation following more data in the future. ARIMA can effectively model stability and fluctuations in the exchange rate which are present in both the annual and quarterly datasets.

According to the forecasts, the Guatemalan Quetzal will likely continue to show stability within the 7.4 to 8.2 range amid possible fluctuations. This stability is beneficial for businesses and families. A stable exchange rate makes it easier for businesses to plan investments and set prices by eliminating the risk of sudden financial loss. Meanwhile, families can send money home knowing that the value will not change significantly. Overall, the stability shown in the model helps in financial planning while having confidence that there is not much risk in sudden changes in value.

CODE:

```
library(fpp2)
Rate <- read.csv(file.choose())
attach(Rate)
head(Rate,n=12)
#QUARTERLY
Ratets<- ts(Rate[,"Value"], start=c(2000,1),frequency =4)
plot(Ratets, main="Guatemalan Exchange Rate(Quarterly)", ylab="Value", xlab="Time", col=6)
ggseasonplot(Ratets,polar=T)
ArimaMod <- auto.arima(Ratets)
summary(ArimaMod)
checkresiduals(ArimaMod)
forecast(ArimaMod,h=20)
plot(forecast(ArimaMod,h=20))
EtsMod <- ets(Ratets)
summary(EtsMod)
checkresiduals(EtsMod)
forecast(EtsMod)
plot(forecast(EtsMod))
rwfMod <-rwf(Ratets,drift=T)
plot(rwfMod)
summary(rwfMod)
checkresiduals(rwfMod)

#YEARLY
yearR <- read.csv(file.choose())
yearR
attach(yearR)
yearRts <- ts(yearR[,"Value"], start=c(2000,1),frequency = 1)
plot(yearRts, main="Guatemalan Exchange Rate(Yearly)", ylab="Value",xlab="Time",col=6)
ArimaMod2 <- auto.arima(yearRts)
```

```
summary(ArimaMod2)
checkresiduals(ArimaMod2)
forecast(ArimaMod2)
plot(forecast(ArimaMod2))
EtsMod2 <- ets(yearRts)
summary(EtsMod2)
checkresiduals(EtsMod2)
forecast(EtsMod2)
plot(forecast(EtsMod2))
rwfMod2 <-rwf(yearRts,drift=T)
plot(rwfMod2)
summary(rwfMod2)
checkresiduals(rwfMod2)
forecast(rwfMod2)
```