# The Central African Republic Exports Analysis Report

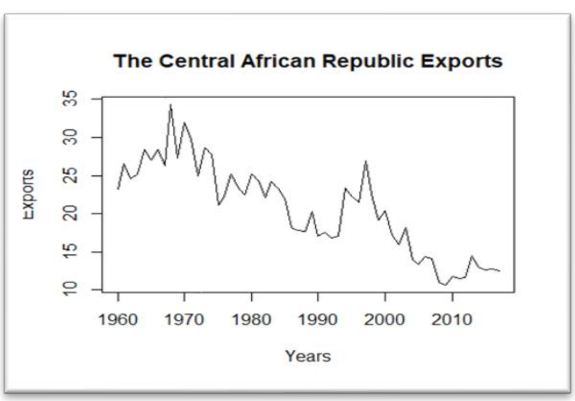
## I. Introduction

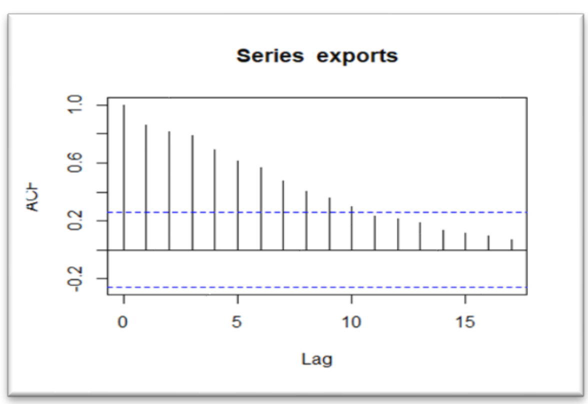
The Central African Republic is one of the world's least-developed countries. However, the country does have many important natural resources, with timber and diamonds dominating exports. I'm interested in studying how the export part affects the country's economy, and I will build a prediction model to forecast the future export trend in this report.

The country has a wealth of mineral resources, so its top exports include Rough Wood, Gold, Diamonds, Sawn Wood, and Refined Copper, exporting mostly to China, United Arab Emirates, Italy, Belgium, and France. However, the country has also been under pressure to protect its natural resources. The conflicts about how best to both protect these resources and boost exports erupted in the 1990s. On top of that, the declination in international prices of cash crop, the continued smuggling of diamonds across the border, and the domestic political unrest strained the economy. The corruption and financial mismanagement made government unable to pay the salaries for military and the public sector.

The data I used for this analysis has 58 observations and describes the economic statistics of the Central African Republic during 1960-2017, including GDP, Imports, Exports, and Population. The number of the Exports in this data represents the Exports of goods and services (% of GDP).

## II. Data Analysis and ARIMA Model Building



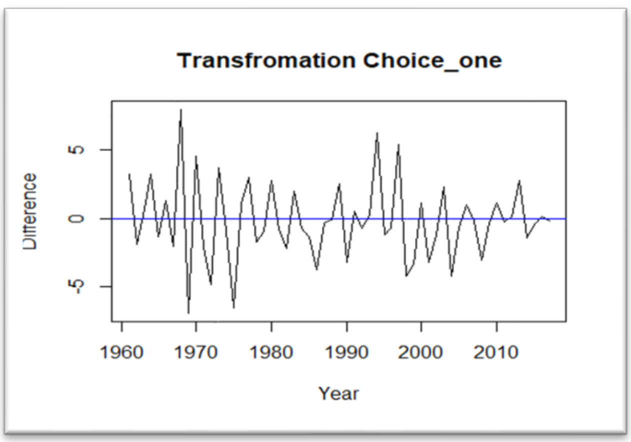



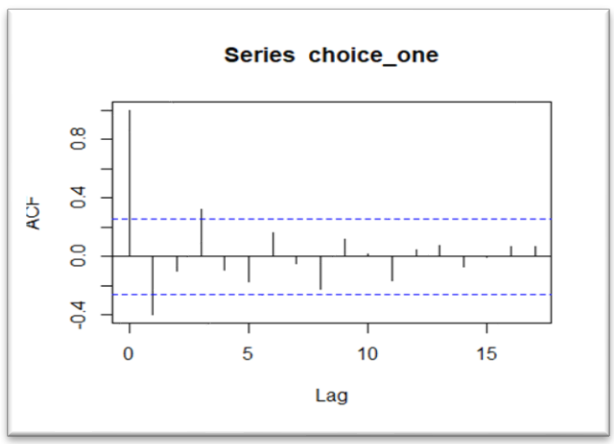
*** Is data Stationary?*

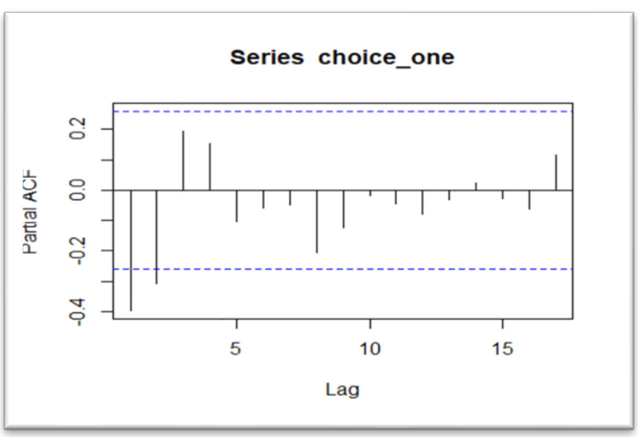
I used tsoutliers() function to examine my data, and there is no unusual or missing value.

The first important step is to determine if our data is stationary or not because non-stationary data is unstable and unpredictable which would give us a poor result. We usually check the trends of the raw data and its autocorrelation (ACF). There is a clear decreasing trend showing in the Exports data which is a sign of non-stationary data since its mean value is not consistent over time. And its ACF value is decreasing slowly and remains a high value above the blue lines (significant range) while the stationary ACF would drop to zero relatively quickly. Based on these two signs, I conclude that the data is nonstationary, and I need to transform it into stationary data.

*** First Transformation—Taking difference ($Z_t = Y_t - Y_{t-1}$)*



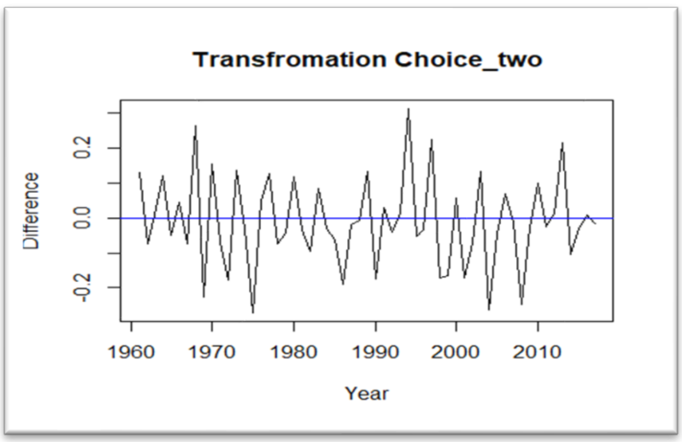



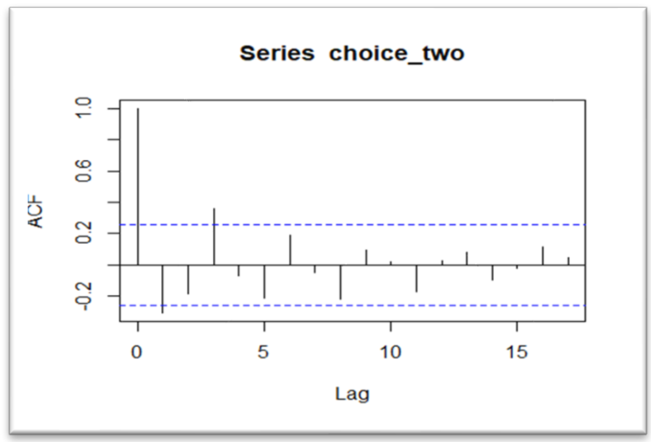

I firstly used a common transformation method–taking first differencing by subtracting one past value.

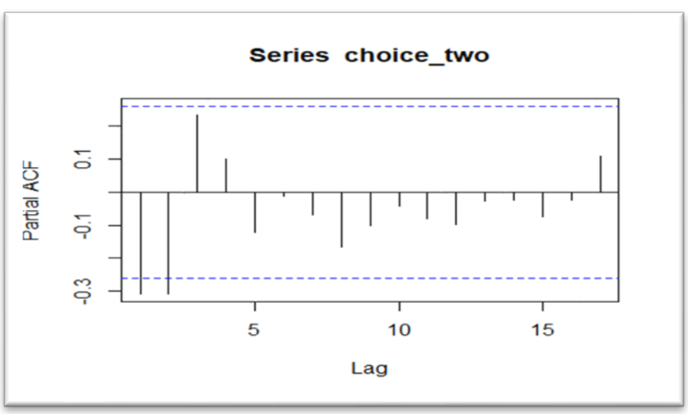
After transformation, I plotted the data again. We can see the difference now; the data values oscillate around the blue line which means the mean is consistent and stable over time. The ACF drops faster, and values are under the significant range lines after lag3. So, I conclude that the taking difference transformation gives me stationary data.

In addition to being used to determine stability, ACF and PACF can also help to choose the order parameter for models. ACF is usually used to determine the order parameter for the MA model, and PACF is usually used to determine for AR or ARMA model. In ACF, the lag1 and lag3 values strike over the significant range, so I would choose MA (1), and MA (3) for candidate models. In PACF, all the values are below the significant range after lag2, so I choose AR (2) as my candidate model.

*** Second Transformation—Taking difference and logarithm ($Q_t = \log X_t - \log X_{t-1}$)*




Even though the data after my first transformation looks good, I still would like to try one more transformation method to see if I can get anything better. After I used the logarithm method to do the second transformation, I see all the graphs does not have much change, and I still got the same candidate models:

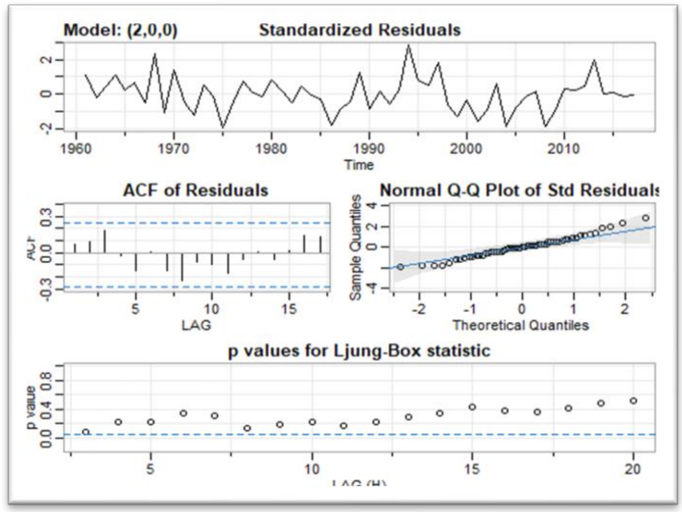
MA (1): $Y_t = W_t + \theta_1 W_{t-1}$

MA (3): $Yt = Wt + \theta_1 Wt_{-1} + \theta_2 Wt_{-2} + \theta_3 Wt_{-3}$

AR (2): $Yt = \phi_1 Yt_{-1} + \phi_2 Yt_{-2} + Wt$

** *Model Diagnosis*

```
> model_ar22
$fit

Call:
arima(x = xdata, order = c(p, d, q), seasonal = list(order = c(P, D, Q), period = S),
    xreg = xmean, include.mean = FALSE, transform.pars = trans, fixed = fixed,
    optim.control = list(trace = trc, REPORT = 1, reltol = tol))

Coefficients:
          ar1      ar2    xmean
      -0.4035  -0.3037  -0.0117
s.e.   0.1263   0.1247   0.0091

sigma^2 estimated as 0.01348:  log likelihood = 41.72,  aic = -75.44

$degrees_of_freedom
[1] 54

$ttable
      Estimate     SE t.value p.value
ar1    -0.4035 0.1263 -3.1957  0.0023
ar2    -0.3037 0.1247 -2.4351  0.0182
xmean  -0.0117 0.0091 -1.2895  0.2027

$AIC
[1] -1.323425

$AICc
[1] -1.315481

$BIC
[1] -1.180053
```




In the diagnosis part, I used sarima() function on both of my transformation choices and compare the results to choose the best-fitted model.

First, I compared AIC and BIC from all my 3 candidate models with two transformation choices and found that AR (2) with transformation choice_two has the lowest AIC and BIC. The AIC and BIC are the indicators to measure the goodness of fit of an estimated model, and the lower value the model has, the better it can fit.

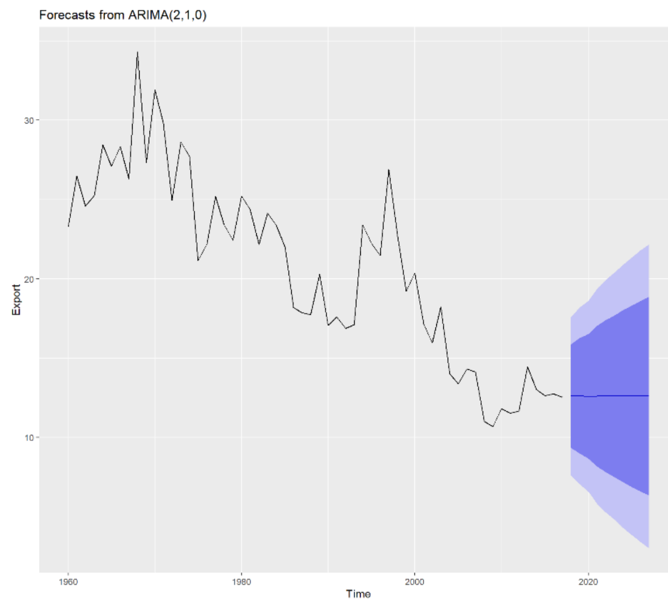
Second, I would check the residuals for AR (2) model. An ideal model's residuals need to meet the following criteria to make sure the model could make an unbiased prediction: 1.no correlation within data values; 2. mean value should be 0; 3. Normally distributed; 4. it is white noise. Here's what I observed from the results: 1. ACF shows all the values are below the significant range; 2. the Normal QQ plot shows all the values fit the indication line well, so it is normal distribution; 3. Ljung-Box test shows all the p-value dots are above the signature line, so we conclude that the residual is white noise and one of the properties of white noise is the mean=0.

After all the analysis, I choose AR (2) as my best prediction model. Now I would determine the coefficient for my model. On the left graph, the p-value for coefficients of AR1 and AR2 are smaller than the significant level of 0.1 so the coefficients are significant. Since the p-value of the mean is bigger than the significant level of 0.1 so it is not significant, and we set it equal to 0. My final AR (2) model would be: $Yt = -0.4035Yt\text{-}1 + 0.3037Yt\text{-}2 + \varepsilon$

Since $Yt = \log Xt - \log Xt_{-1}$ => $\log Xt = Yt + \log Xt_{-1}$ => $Xt = e^{Yt + logXt-1}$

** *Forecasting*

```
> MyPrediction
     Point Forecast     Lo 80    Hi 80    Lo 95    Hi 95
2018       12.59070 9.330721 15.85068 7.604991 17.57641
2019       12.61514 8.977688 16.25259 7.052138 18.17814
2020       12.58176 8.646884 16.51664 6.563886 18.59964
2021       12.59154 8.161751 17.02133 5.816762 19.36632
2022       12.59627 7.815613 17.37693 5.284886 19.90765
2023       12.59105 7.495778 17.68632 4.798504 20.38359
2024       12.59232 7.171927 18.01270 4.302547 20.88208
2025       12.59319 6.876822 18.30955 3.850761 21.33561
2026       12.59238 6.597074 18.58769 3.423351 21.76141
2027       12.59254 6.326709 18.85836 3.009782 22.17529
> autoplot(MyPrediction,xlab="Time",ylab="Export")
```




I used ARMA (2,1,0) model that I just built to forecast the next 10 years after 2017, the exports tend to be stable at around 12 each year. The forecast tells us 80% of confidence that the lowest exports would be changing from 6.347 to 18.858 and 95% of confidence that the exports would be changing from 3.009 to 22.175. The dark purple area represents the 80% prediction interval, and the light purple area represents the 95% prediction interval.

I did research the real data of the exports in 2018-2020 from The World Bank and the values are in my prediction interval–export was 18.9 in 2018; exports stayed the same for 2019 and 2020 which was 16.4. So, my prediction is closes to the true value.

## III. Conclusion

Trade is the key to ensuring the Central African Republic’s long-term and sustainable economic growth. In the past few decades, the highest export was 34.3% of GDP in 1970 and then showed a downward trend after that. The lowest export volume occurred during the global financial crisis in 2008 and then they were slowly recovering. According to the prediction made by my model for the next decade, the export volume would not rebound to its peak and may even fall below the lowest value in 2008.

Strengthening import and export trade is an important way to reduce poverty and improve the economic level in Africa. Therefore, I think Africa needs to reorganize its internal structures and develop multiple channels to promote import and export trade.

Reference


Britannica. “Economy of the Central African Republic”. Accessed 6/4/2022.

https://www.britannica.com/place/Central-African-Republic/Economy.

The World Bank. “Exports of goods and services (% of GDP) – Central African Republic.

https://data.worldbank.org/indicator/NE.EXP.GNFS.ZS?end=2020&locations=CF&most_recent_year_desc=true&start=1960&view=chart. Accessed 6/3/2022.