Turkiye's Growth 1999 - 2022

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Contents

Rationale and Research Questions

How does GDP growth relate to investment growth, capital accumulation and population growth in Turkiye from 1999-2022 period? Does electricity consumption have any relationship with GDP, investment and population?

Sub-Questions:

Has electricity consumption increased with GDP growth during the period from 1999 to 2022 in Turkiye? Have electricity consumption increased with investment and population growth during the period from 1999 to 2022 in Turkiye?Is there a quantifiable impact of electricity consumption on GDP growth in Turkiye, when considering the effects of investment and population growth?

Background

We have analyzed the impact of investment growth, population growth and electricity consumption on the GDP growth of Turkiye for the period of 1999-2022. We obtained a dataset from Turkiye and recorded the data points as log growth points. Our aim is to explore the interdependencies between critical economic indicators that influence Turkiye's economic landscape over a significant period. By examining the correlations among these variables, we aim to understand how each one potentially impacts or correlates with the others, particularly in terms of GDP growth. Our analysis seeks to scrutinize the interactions between GDP growth and key growth indicators such as population, investment and electricity consumption to illuminate the intertwined influences of these variables from 1999 to 2022.

Significance

Understanding the relationship between electricity consumption and GDP growth is crucial for improving stable economic growth and development. It is important to understand the behavior of electricity consumption in relation to the economy. This understanding is essential for developing informed economic policies and investment strategies. By identifying the strength and direction of these relationships, policymakers and economists can better predict future trends and make decisions that aim to foster economic stability and growth. Grasping the dynamics between electricity consumption and GDP growth is essential for strategies that underpin economic stability and advancement. These findings reinforce the importance of electricity in bolstering economic development, as noted by Kasperowicz (2014).

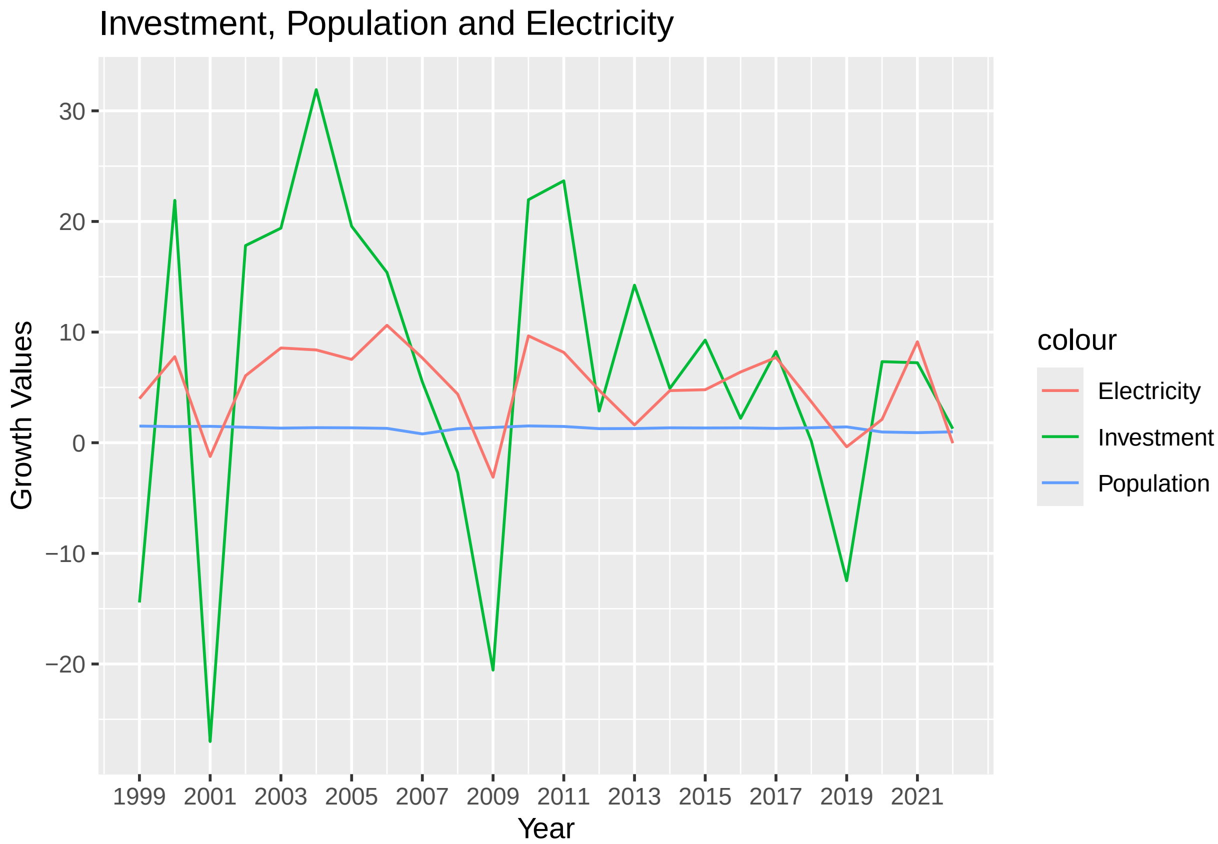
Theoretical Context

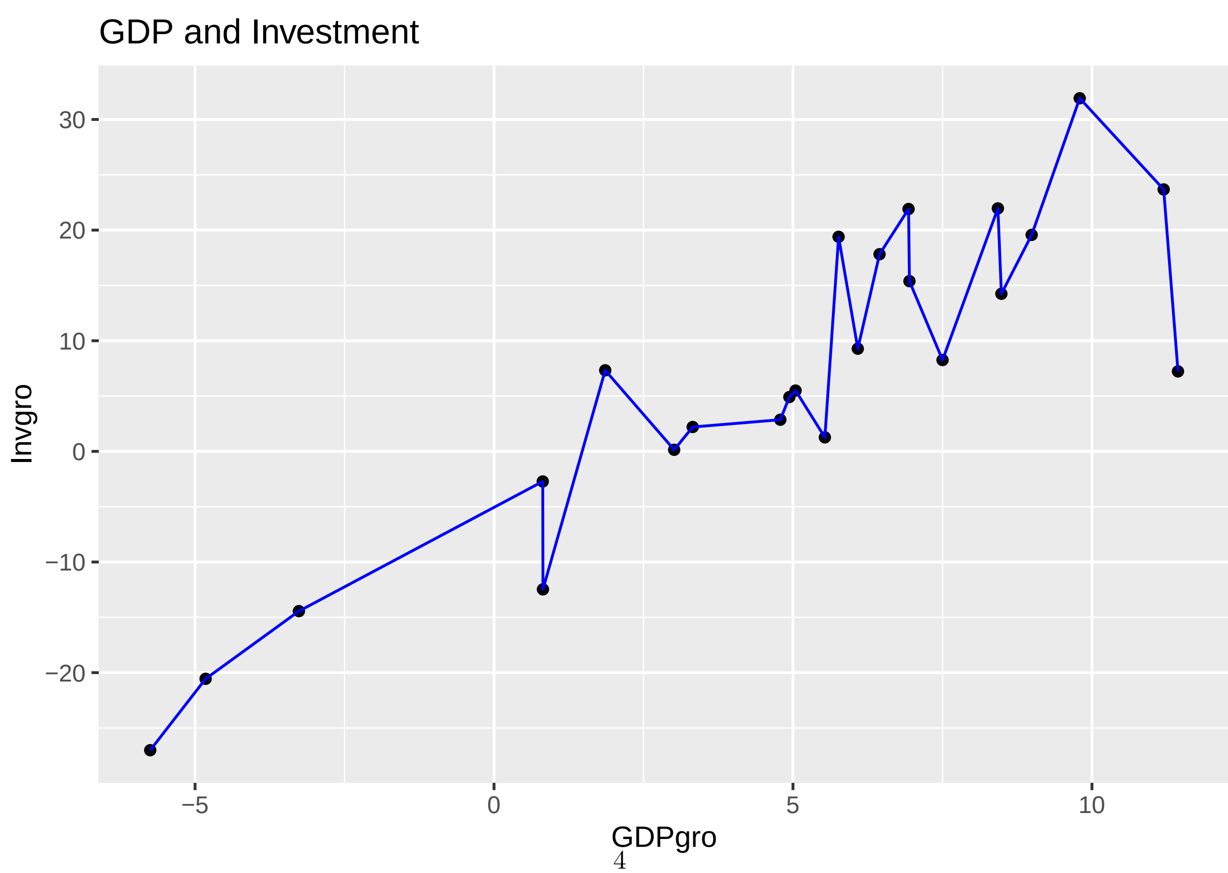
The central hypothesis of this research is that an increase in electricity consumption is linked to GDP growth. This hypothesis is based on the understanding that investment, population, and electricity consumption are key factors that contribute to GDP growth. The hypothesis for this analysis suggests that there are significant correlations between GDP growth and other important economic indicators such as population growth, investment growth, and electricity consumption. By analyzing these correlations, we can verify the interconnectedness of these variables and determine whether they support or refute prevailing economic theories about their interactions. The hypothesis central to this analysis posits that rising electricity consumption acts as a catalyst for GDP growth. This supposition is based on the idea that investment, demographic changes, and energy consumption together help explain the narrative of GDP growth.

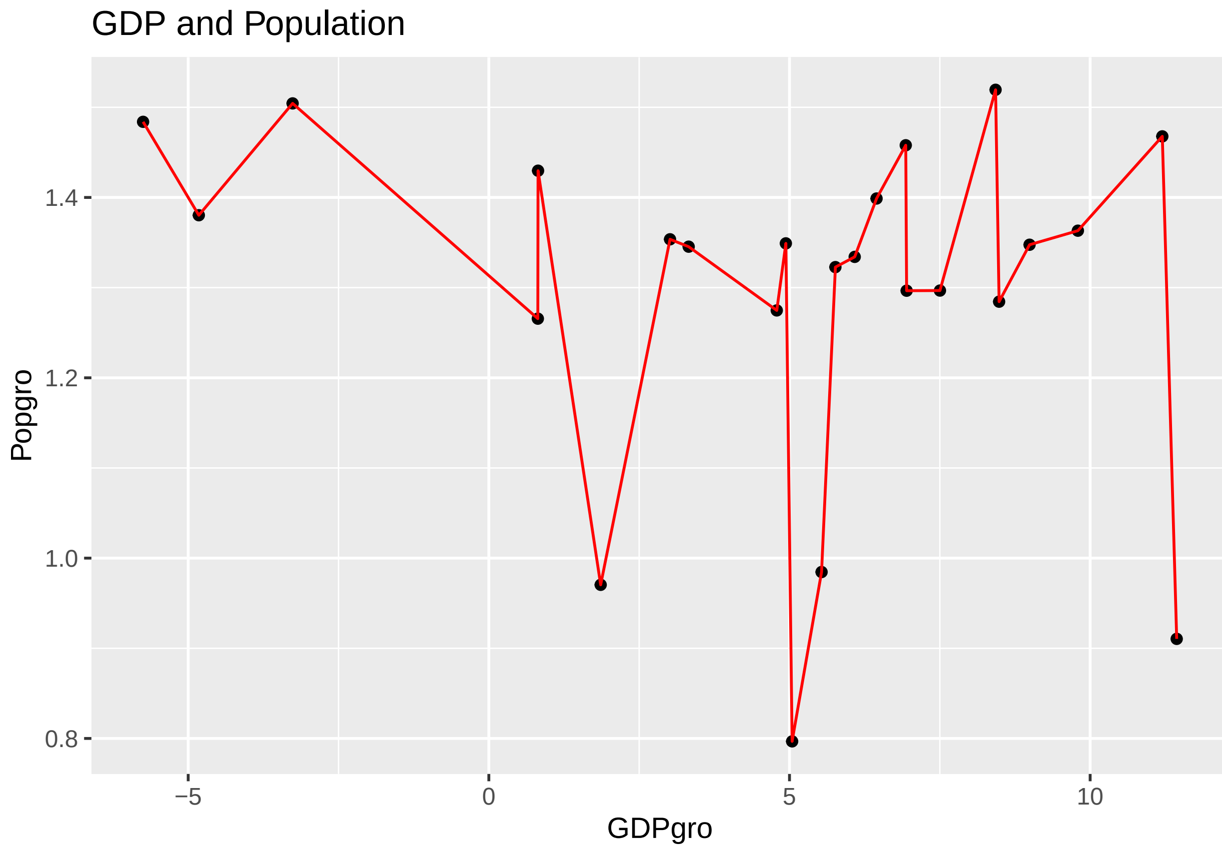
Dataset Information

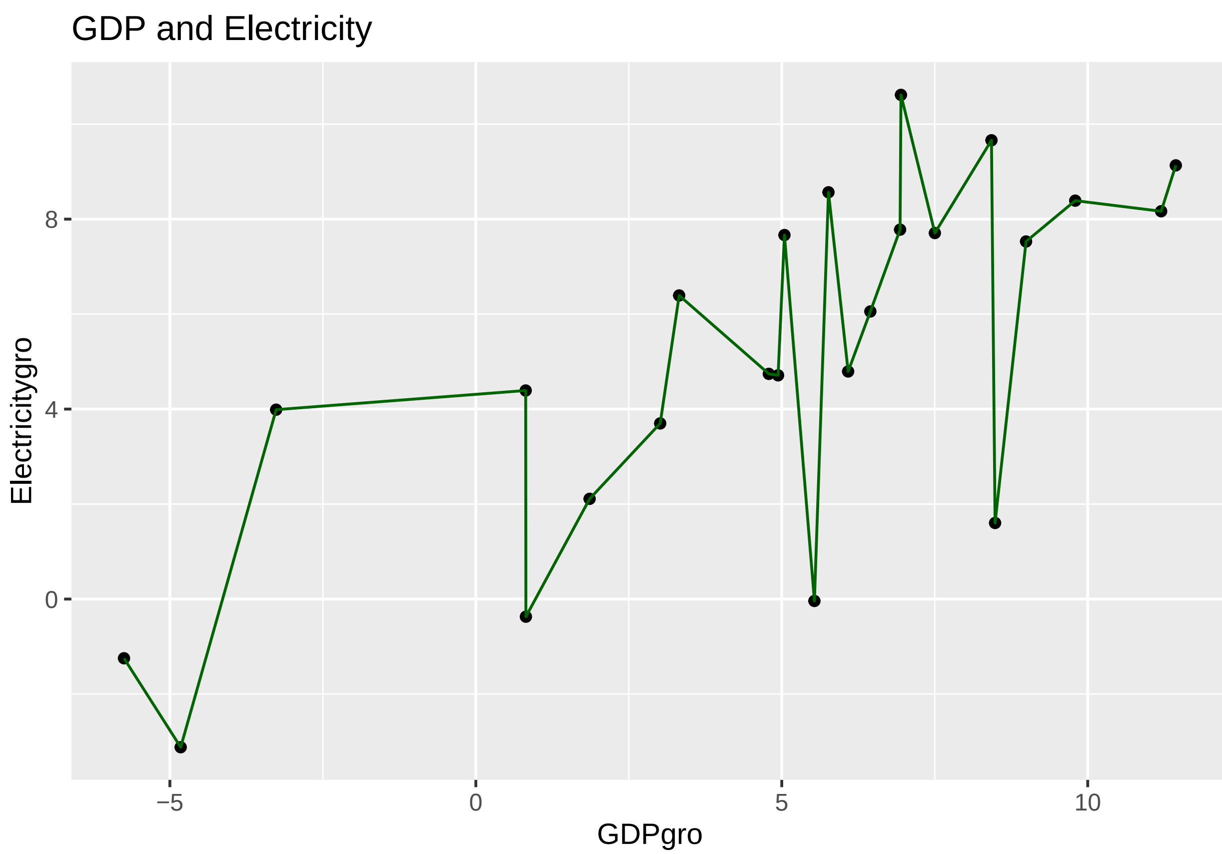
This analysis uses three databases: (https://ytbsbilgi.teias.gov.tr/ytbsbilgi/frm_istatistikler.jsf) for electricity consumption; (https://data.tuik.gov.tr/Kategori/GetKategori?p=ulusal-hesaplar-113&dil=2) for GDP growth rate; (https://databank.worldbank.org/source/world-development-indicators) for investment and population growth. The Solow–Swan model or exogenous growth model is an economic model of long-run economic growth. It attempts to explain long-run economic growth by looking at capital accumulation, labor or population growth, and productivity increases largely driven by technological progress. In our analysis, parallel with Solow-Swan model we assume that the production function takes the following form: Y = aKbL1-b where $0 < b < 1$. The production function is known as the Cobb-Douglas Production function, which is the most widely used neoclassical production function. We analyze the effect of investment growth which corresponds to capital accumulation and population growth on the GDP growth of Turkiye for the 1999-2022 period. We also analyze the impact of electricity consumption on the GDP growth. For details of each database, please refer to the files in the Metadata folder under the Data folder.

Exploratory Analysis

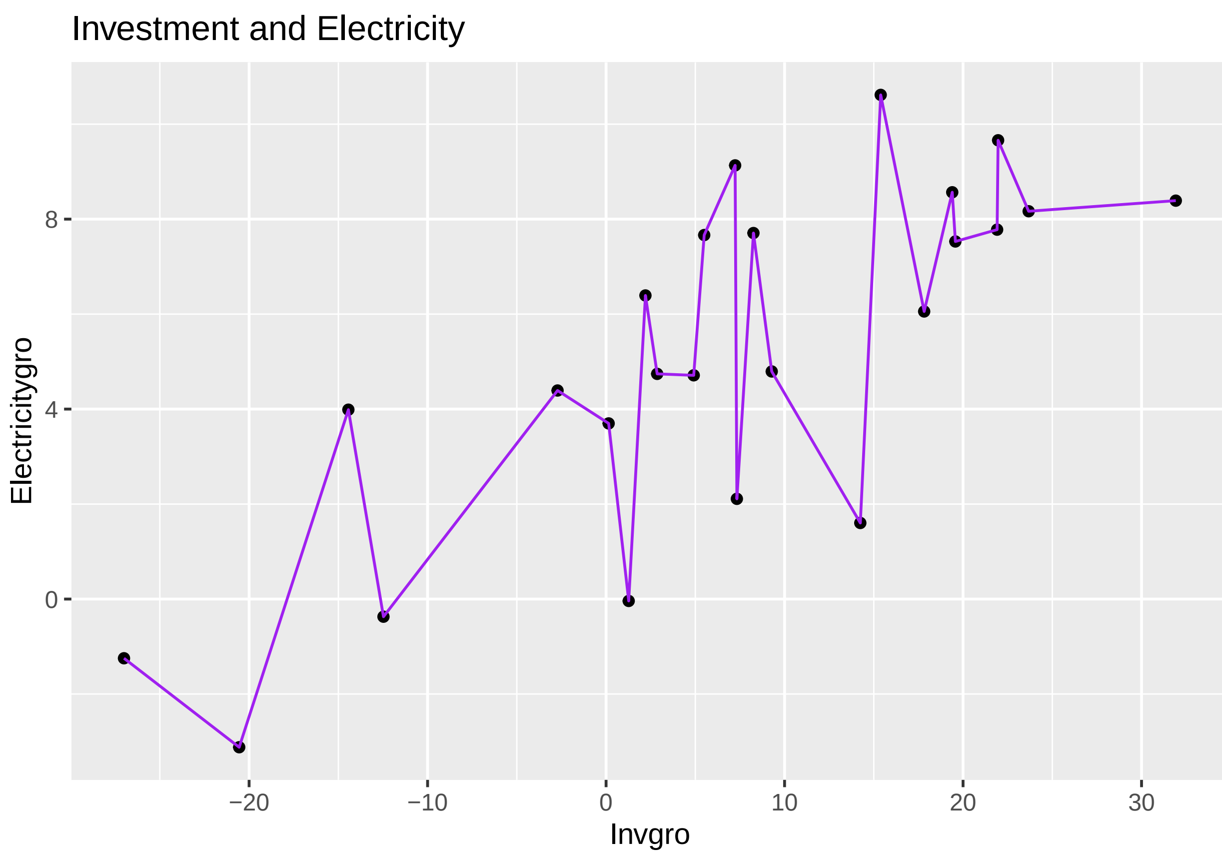




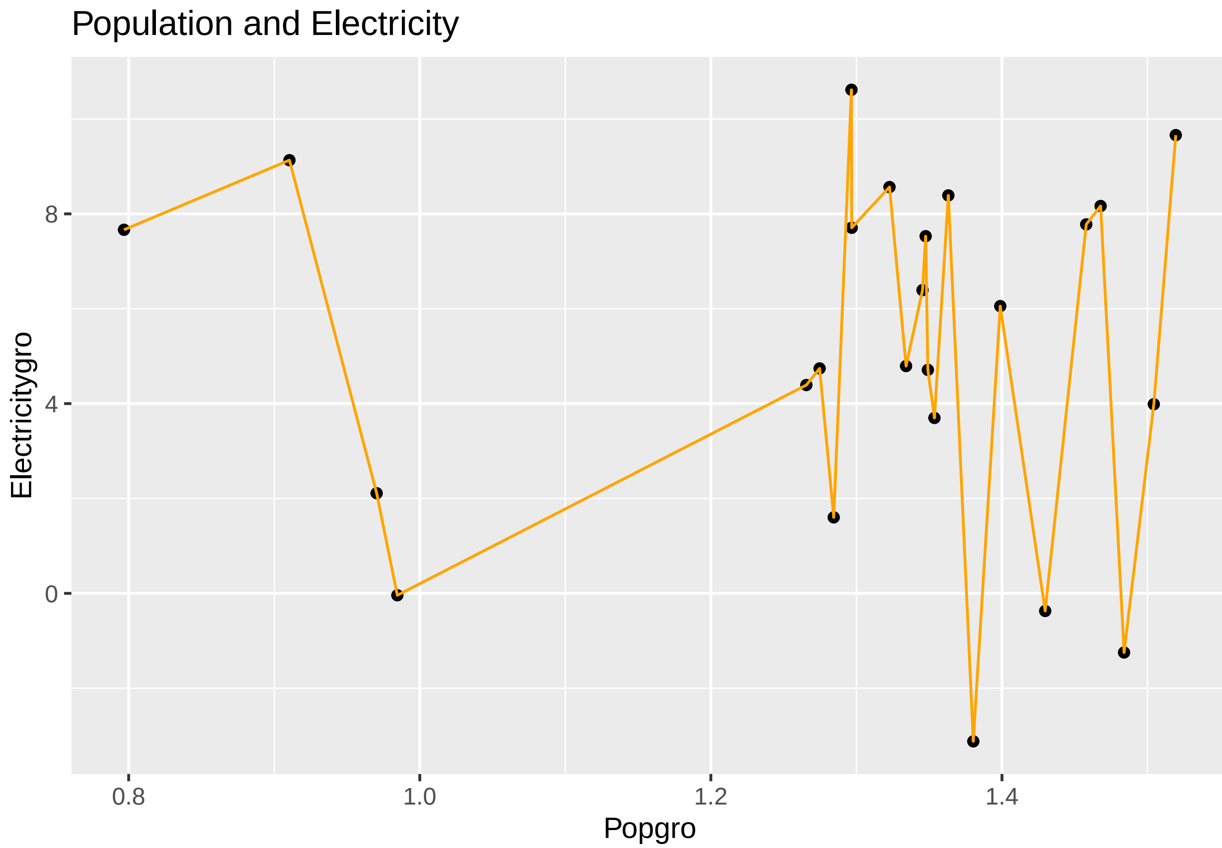

GDP and Population
Popgro
1.4
1.2
1.0
0.8
−5
0
5
10
GDPgro

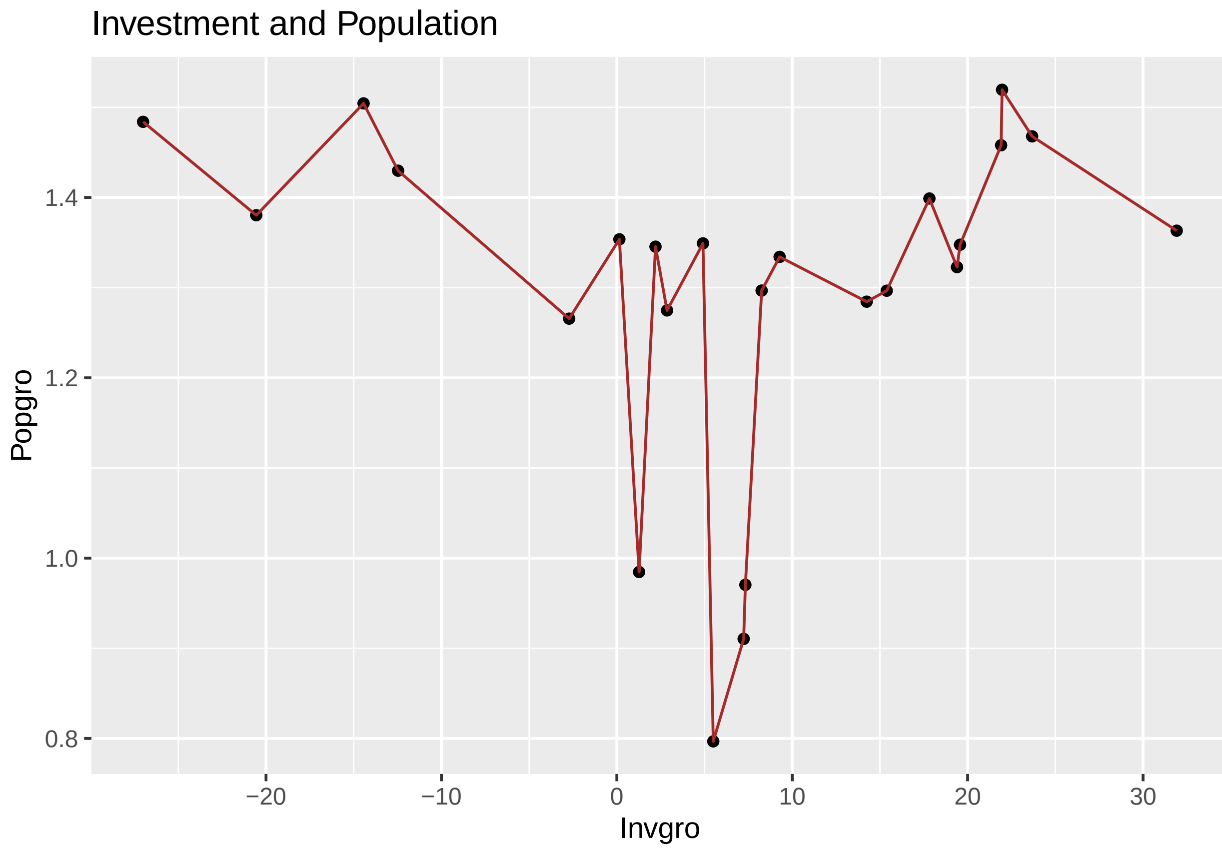


GDP and Electricity
Electricitygro
8
4
0
−5
0
5
10
GDPgro



Investment and Electricity
Electricitygro
8
4
0
−20
−10
0
10
20
30
Invgro

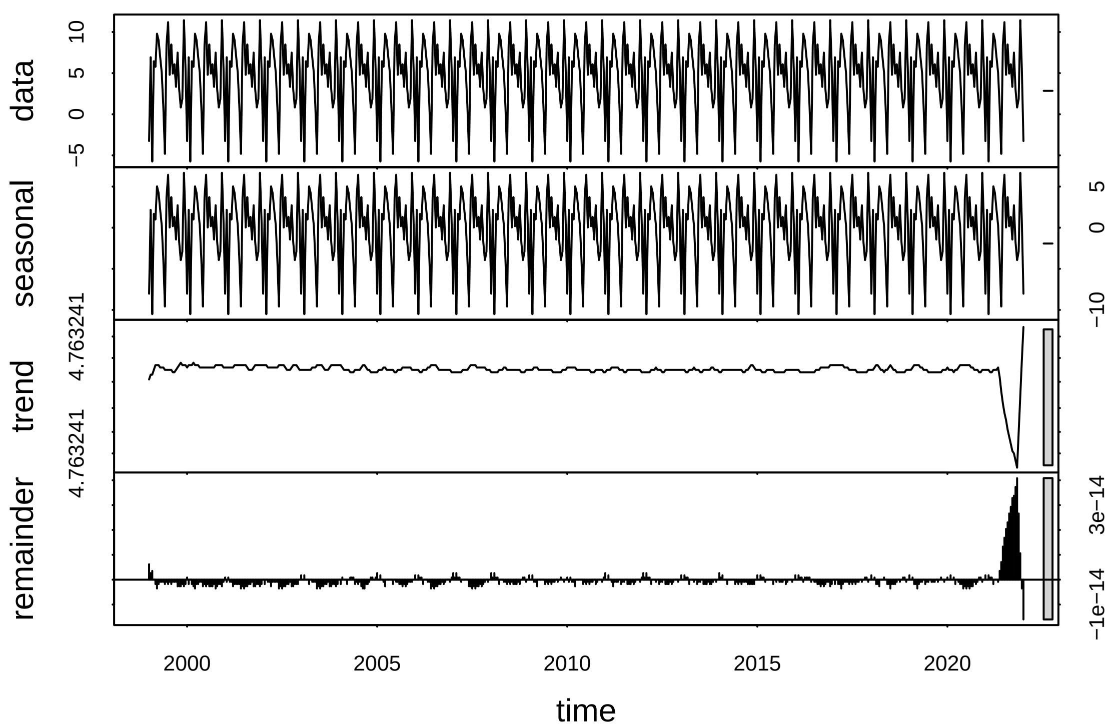

Population and Electricity
Electricitygro
8
4
0
0.8
1.0
1.2
1.4
Popgro

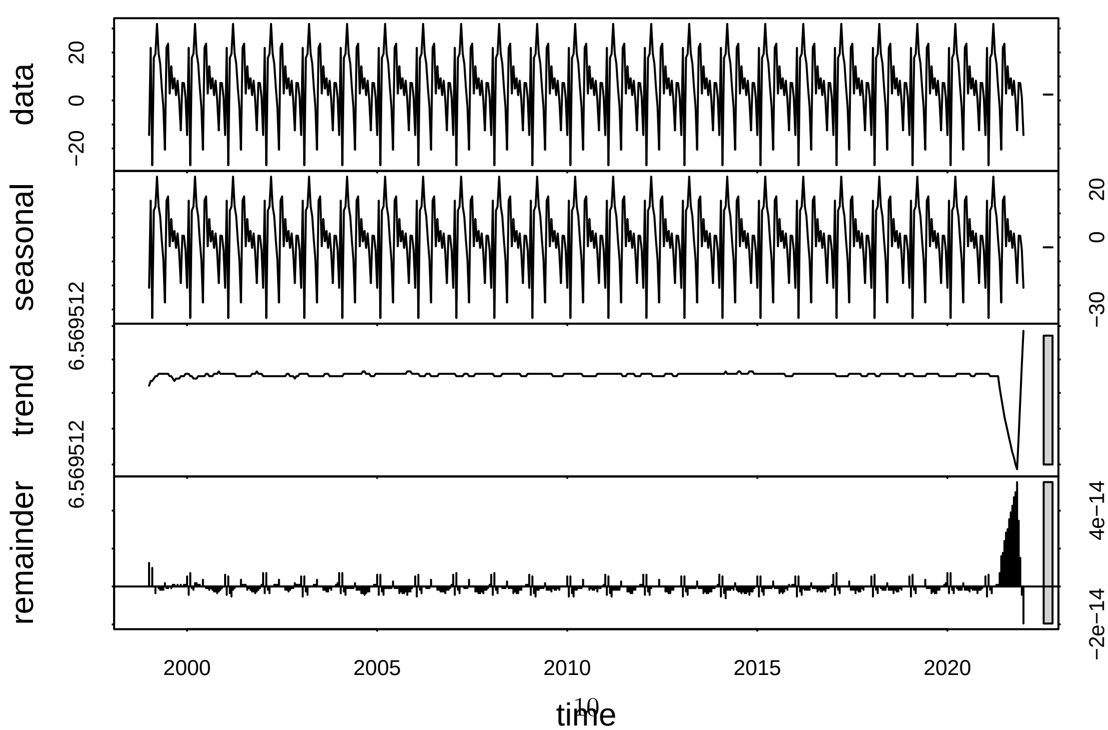


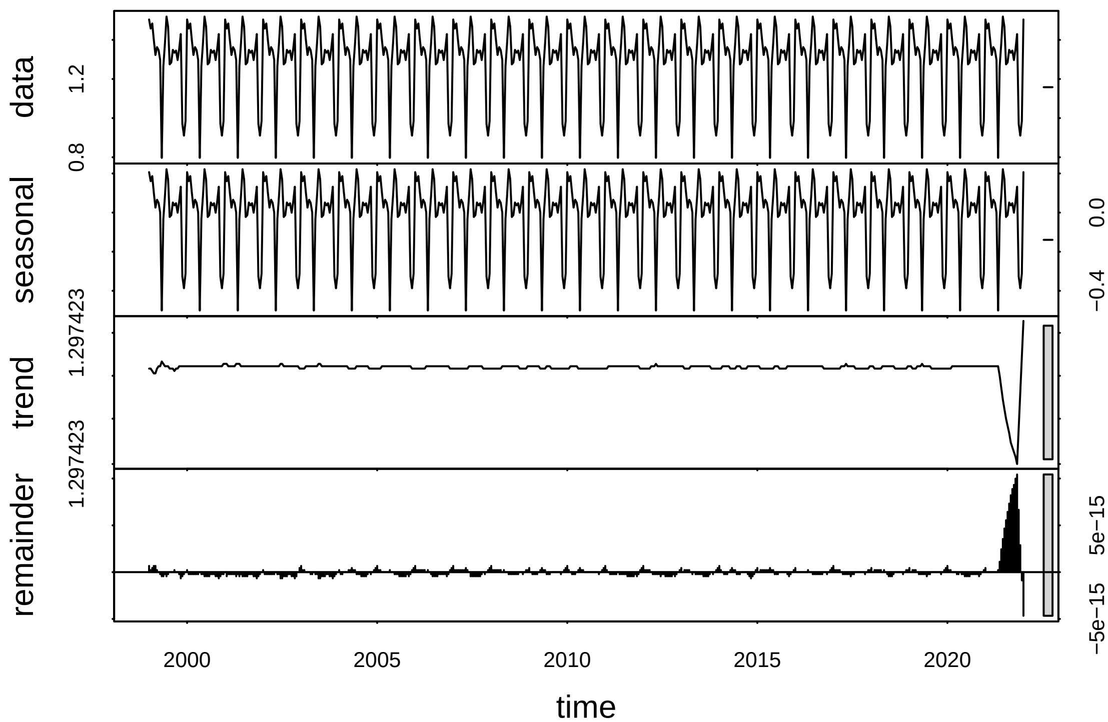
Explanation: - In the first plot, Investment growth, Population growth, and Electricity consumption growth are represented from 1999 to 2022. Population changes are smooth and stable, while electricity consumption changes occur within a short range. Investment growth fluctuates widely and is far from being stable from year to year. - In the second plot, GDP growth is represented on the x-axis, and Investment growth is represented on the y-axis. There appears to be a positive relationship between the two variables; higher investments correspond to higher GDP growth. - In the third plot, GDP growth is represented on the x-axis, and Population growth is represented on the y-axis. There appears not to be a positive relationship between the two variables; even negative population changes correspond to higher GDP growth. - In the fourth plot, GDP growth is represented on the x-axis, and Electricity consumption growth is represented on the y-axis. There appears to be a positive relationship between the two variables. - In the fifth plot, Investment growth is represented on the x-axis, and Electricity consumption is represented on the y-axis. There appears to be a positive relationship between the two variables; higher investments correspond to higher electricity consumpton. - In the sixth plot, population growth is represented on the x-axis, and Electricity consumption is represented on the y-axis. There appears not to be a positive relationship between the two variables. - In the seventh plot, Investment growth is represented on the x-axis, and Population growth is represented on the y-axis. There appears not to be a significant relationship between the two variables.

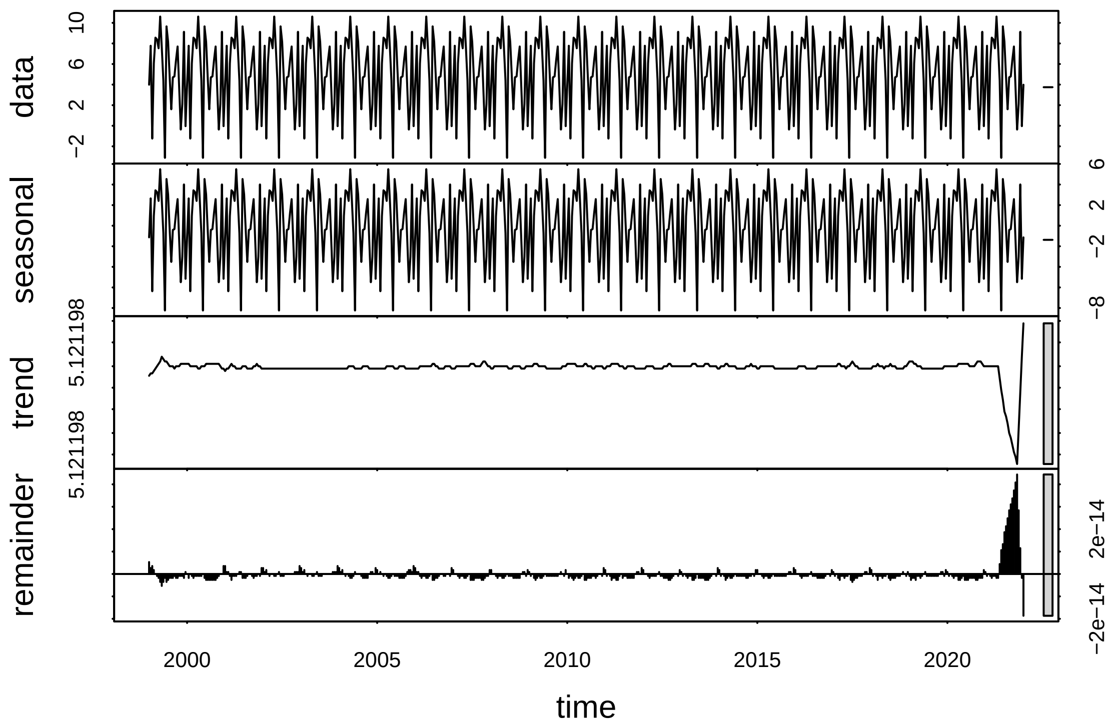
Analysis

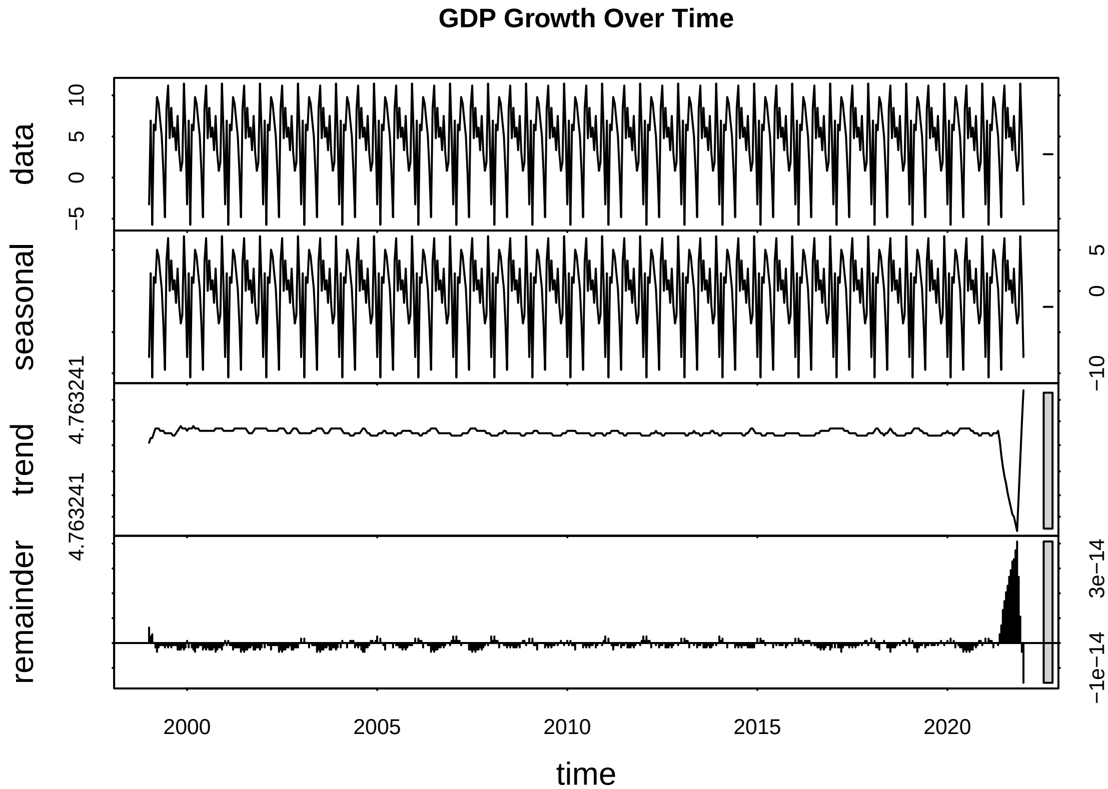
Time Series Analysis



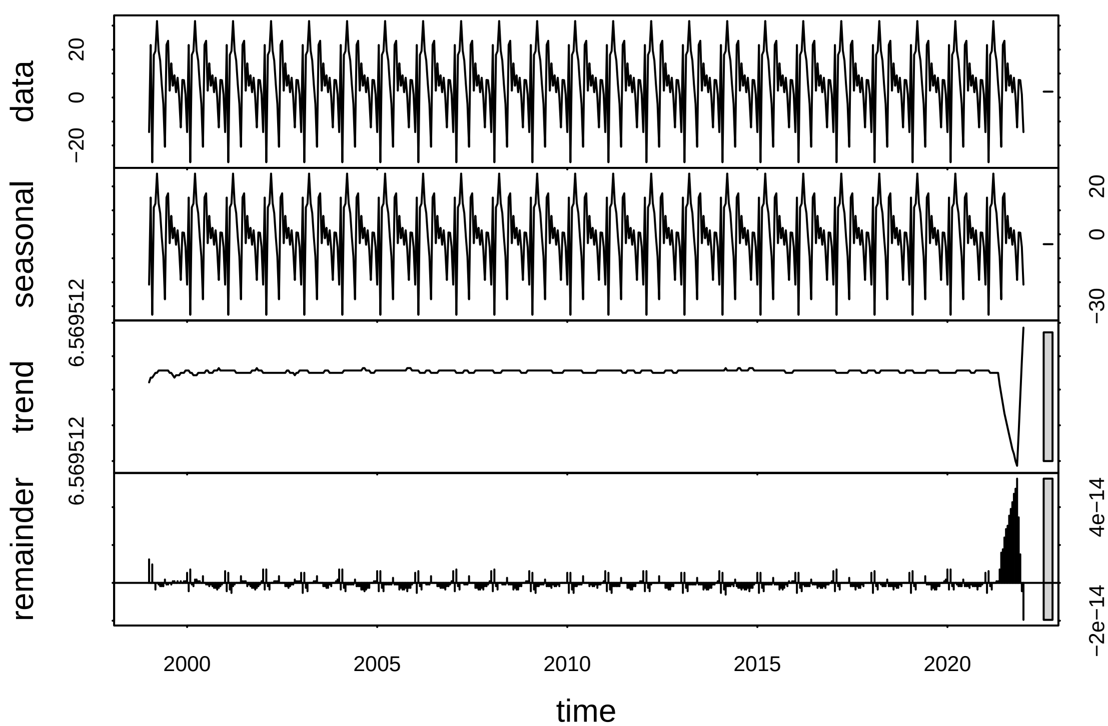



data
1.2
0.8
seasonal
0.0
−0.4
trend
1.297423
1.297423
remainder
1.297423
5e−15
−5e−15
2000
2005
2010
2015
2020
time

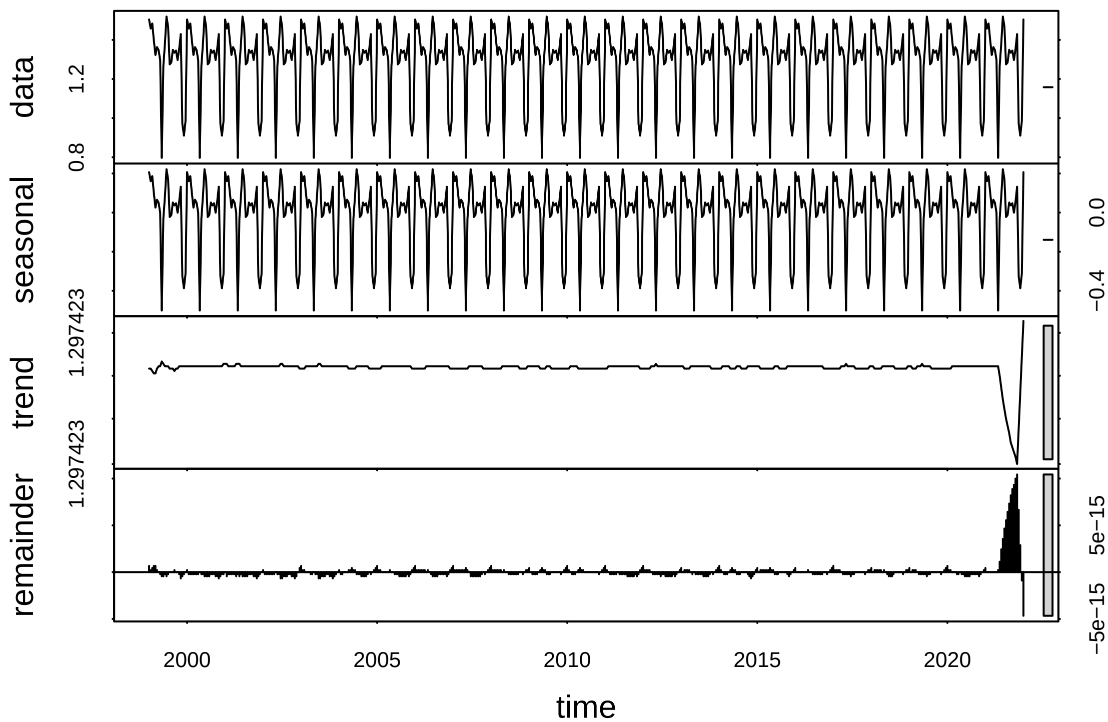

data
seasonal
trend
remainder
10
6
2
−2
6
2
−2
−8
5.121198
5.121198
2e−14
−2e−14
2000
2005
2010
2015
2020
time

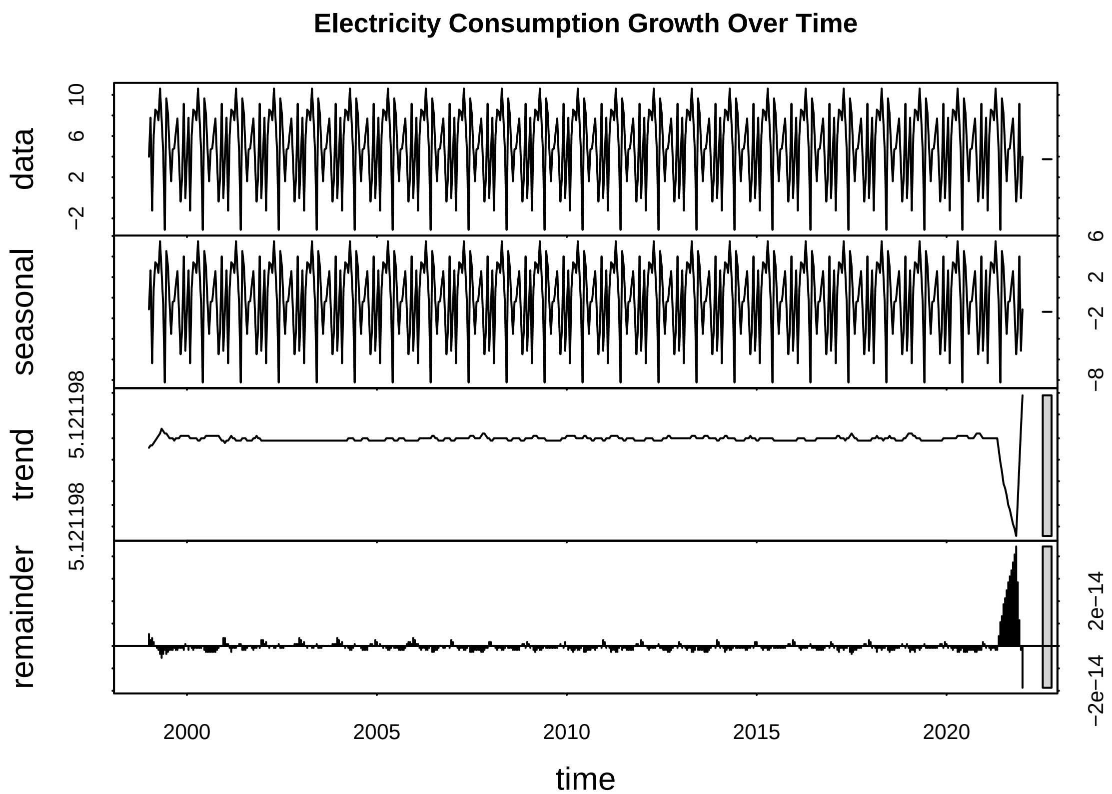

GDP Growth Over Time
data
seasonal
trend
remainder
10
5
0
−5
5
0
−10
4.763241
4.763241
3e−14
−1e−14
2000
2005
2010
2015
2020
time

Investment Growth Over Time



Population Growth Over Time

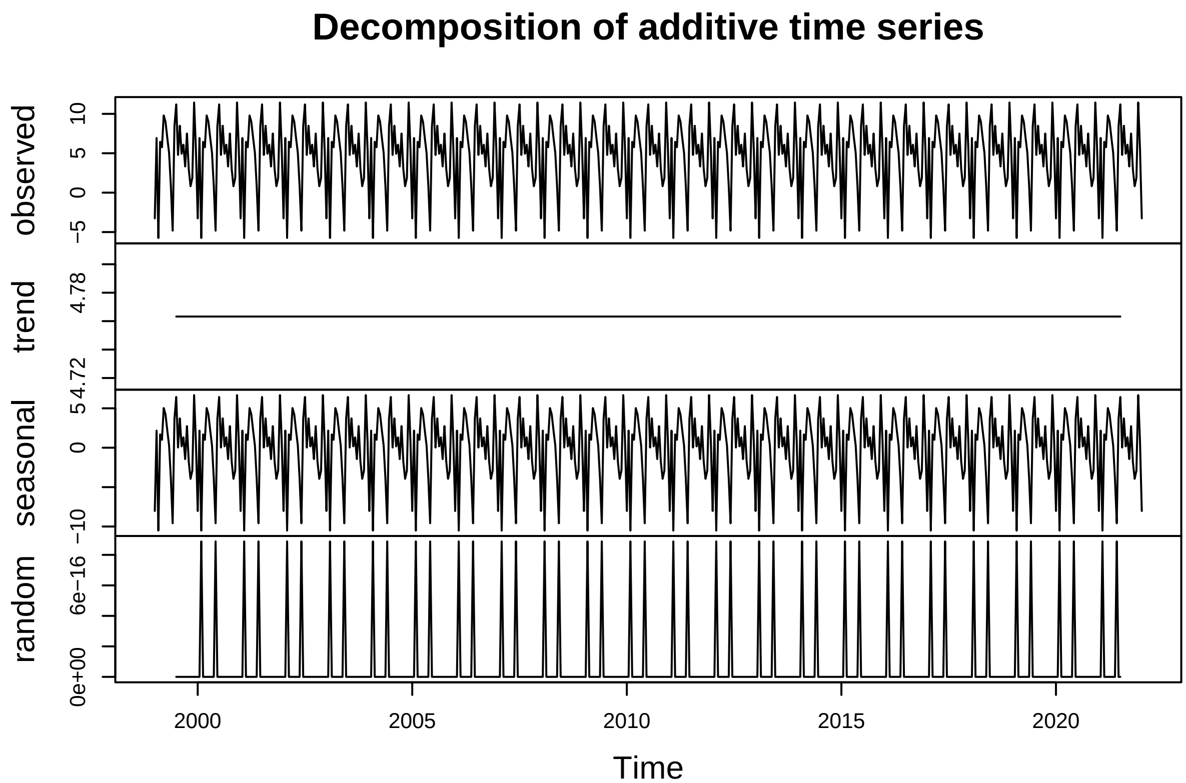


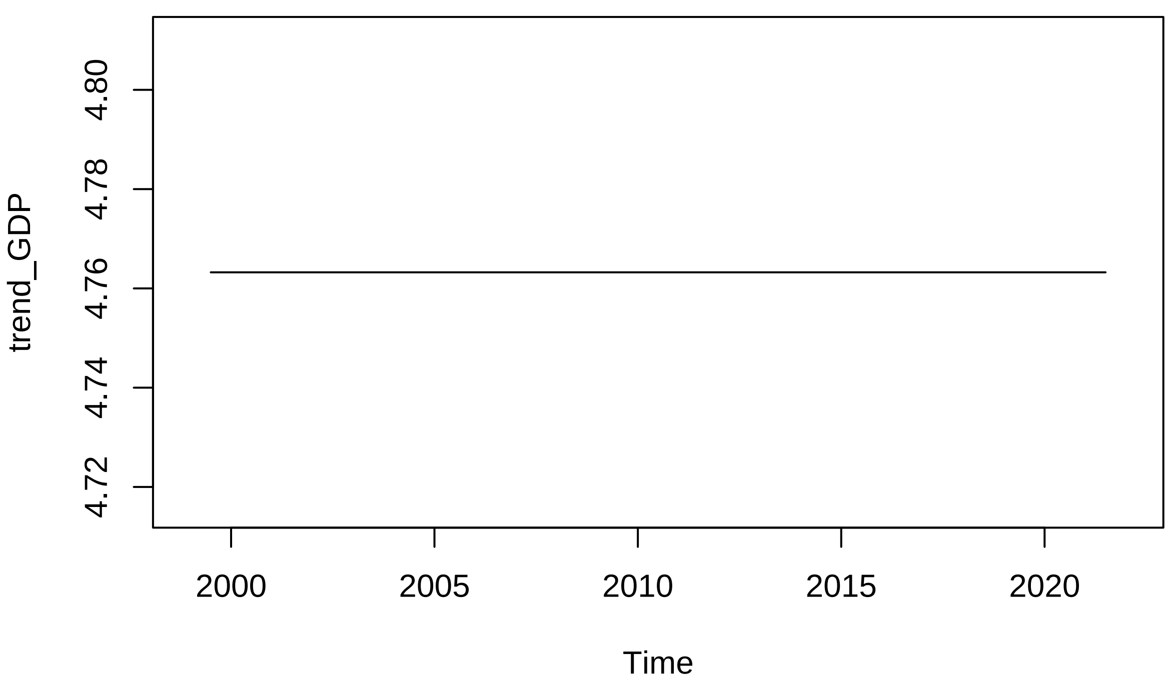


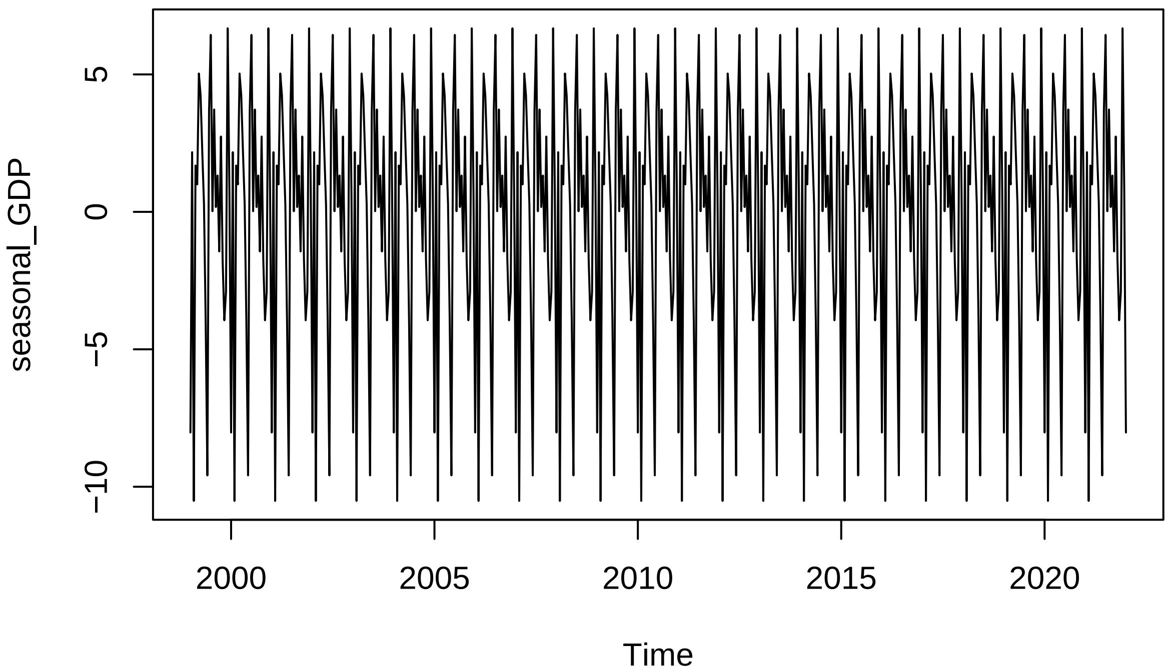
Merve, there is eight plot above.

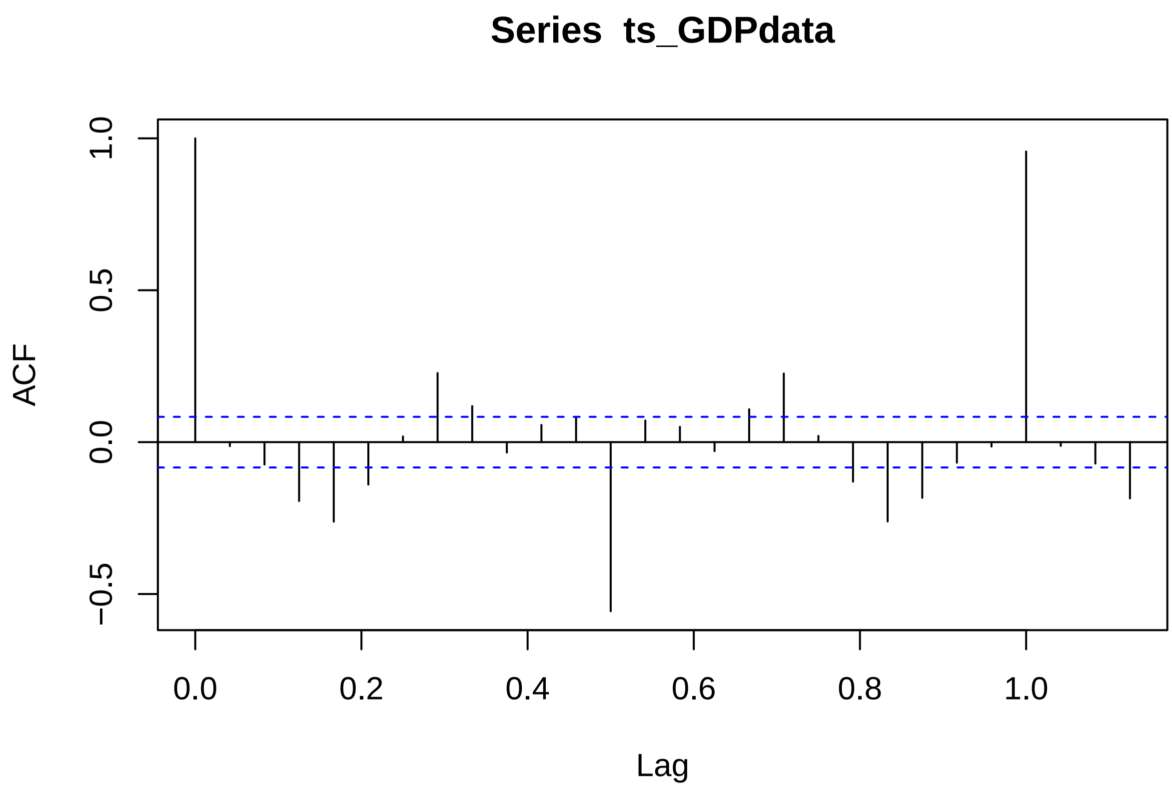
- **First Plot**: In the first plot, decomposed GDP growth data is presented. The data does not exhibit seasonality due to its yearly nature, and there is also no discernible upward or downward trend. However, following the Covid-19 pandemic, the shock creates outlier effects on the data.
- **Second Plot**: In the second plot, decomposed Investment growth data is presented. The data does not exhibit seasonality due to its yearly nature, and there is also no discernible upward or downward trend. However, following the Covid-19 pandemic, the shock creates outlier effects on the data.
- **Third Plot**: In the third plot, decomposed Population growth data is presented. The data does not exhibit seasonality due to its yearly nature, and there is also no discernible upward or downward trend. However, following the Covid-19 pandemic, the shock creates outlier effects on the data.
- **Fourth Plot**: In the fourth plot, decomposed Electricity consumption growth data is presented. The data does not exhibit seasonality due to its yearly nature, and there is also no discernible upward or downward trend. However, following the Covid-19 pandemic, the shock creates outlier effects on the data.
- **Fifth Plot**: In the fifth plot, GDP growth time series data is presented. The data does exhibit fluctuations, but apart from a few years, it shows an increase.
- **Sixth Plot**: In the sixth plot, Investment growth time series data is presented. The data does exhibit fluctuations, but apart from a few years, it shows an increase.
- **Seventh Plot**: In the seventh plot, Population growth time series data is presented. The data does exhibit fluctuations, but apart from a few years, it shows an increase.
- **Eighth Plot**: In the eighth plot, Electricity consumption growth time series data is presented. The data does exhibit fluctuations, but apart from a few years, it shows an increase.

Forecasting

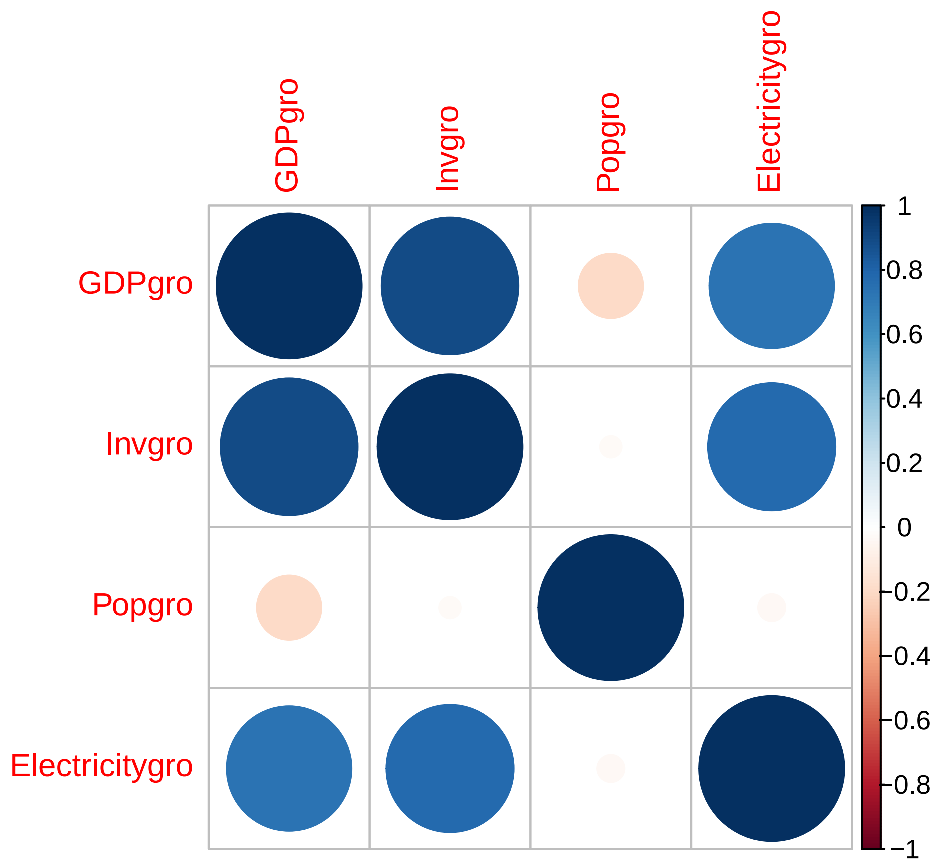


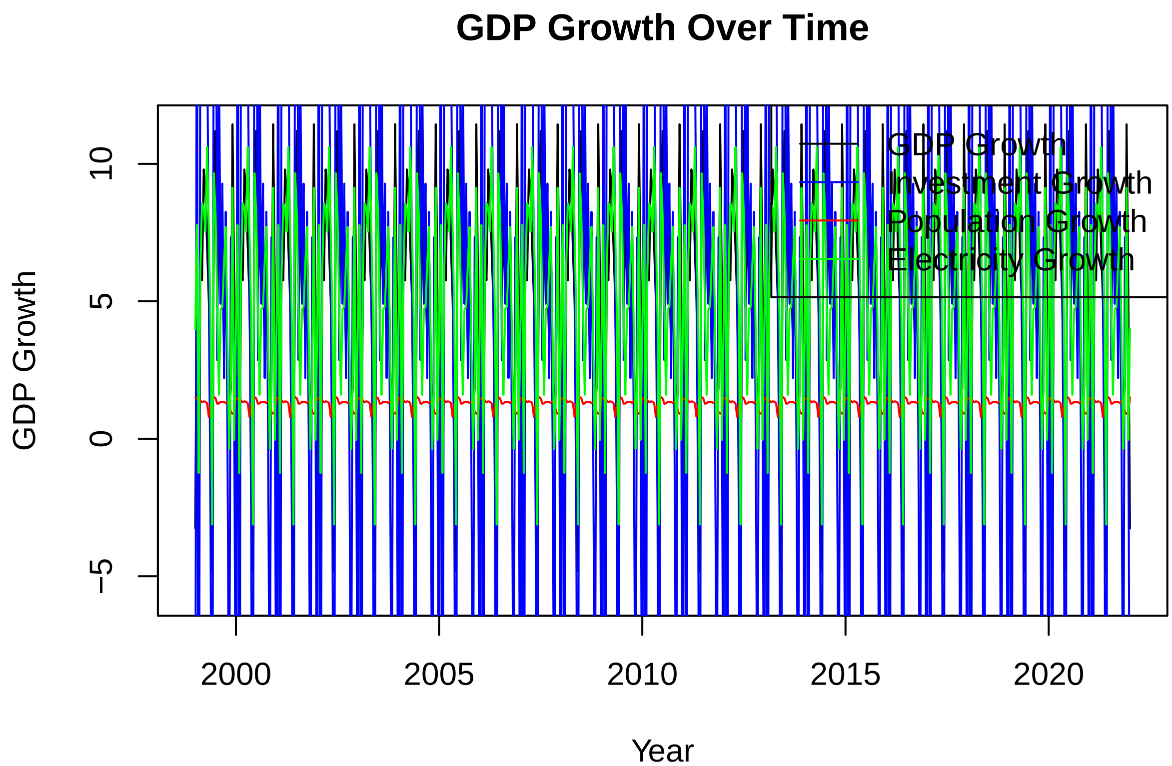



seasonal_GDP
5
0
−5
−10
2000
2005
2010
2015
2020
Time

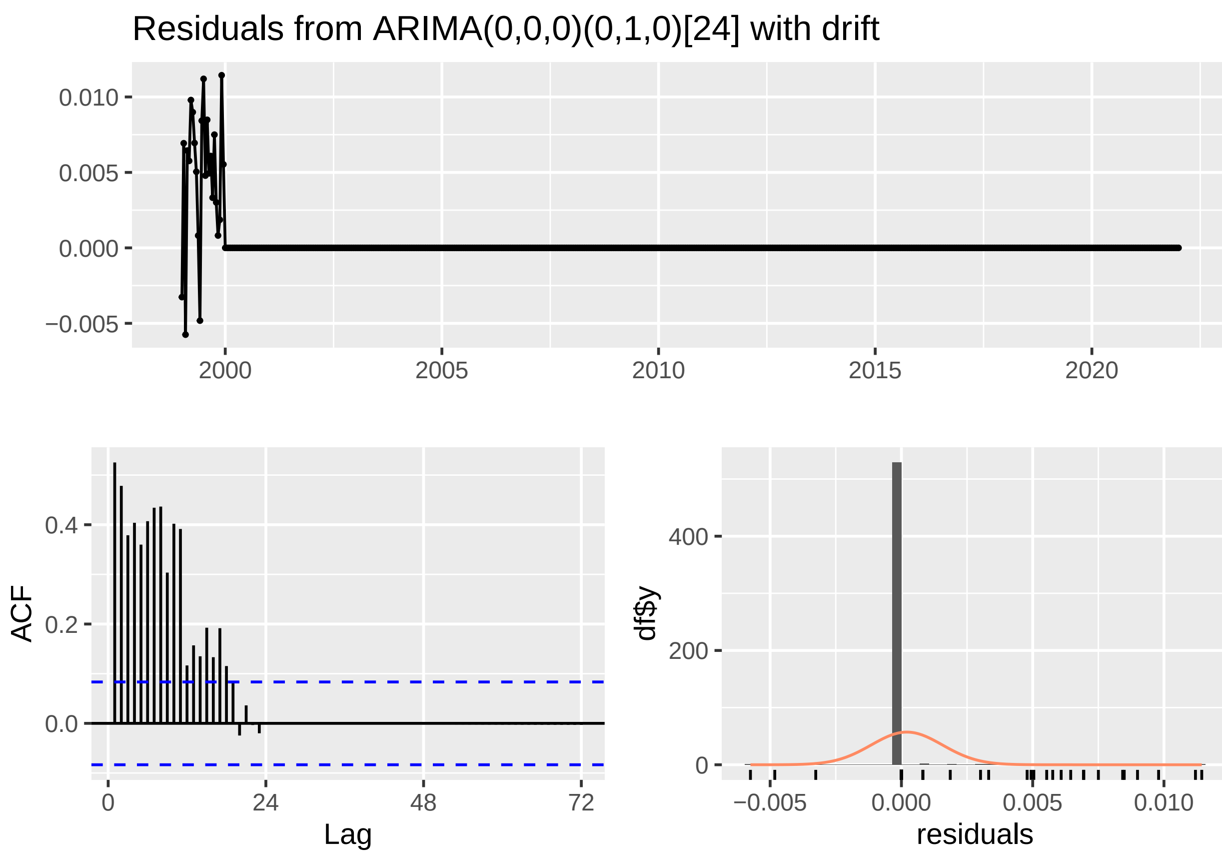


Series ts_GDPdata
ACF
1.0
0.5
0.0
−0.5
0.0
0.2
0.4
0.6
0.8
1.0
Lag

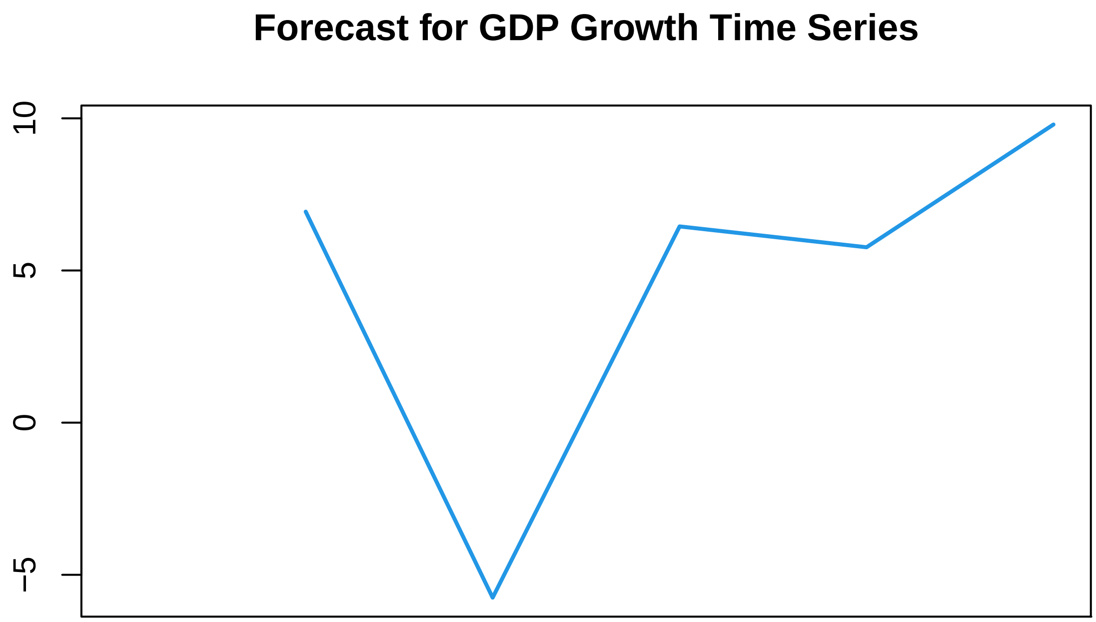

GDPgro
Invgro
Popgro
Electricitygro
GDPgro
Invgro
Popgro
Electricitygro
1
0.8
0.6
0.4
0.2
0
−0.2
−0.4
−0.6
−0.8
−1




```
## Series: ts_GDPdata
## ARIMA(0,0,0)(0,1,0)[24] with drift
##
## Coefficients:
## drift
##     0
##
## sigma^2 = 1.958e-06:  log likelihood = 19091.43
## AIC=-38180.86   AICc=-38180.86   BIC=-38176.59
##
## Training set error measures:
##                        ME        RMSE          MAE         MPE        MAPE MASE
## Training set 0.0002067228 0.001368634 0.0002567638 0.004339962 0.004339962  Inf
##                   ACF1
## Training set 0.5253624
```




```
##
##  Ljung-Box test
##
## data:  Residuals from ARIMA(0,0,0)(0,1,0)[24] with drift
## Q* = 1158.7, df = 48, p-value < 2.2e-16
##
## Model df: 0.   Total lags used: 48
```



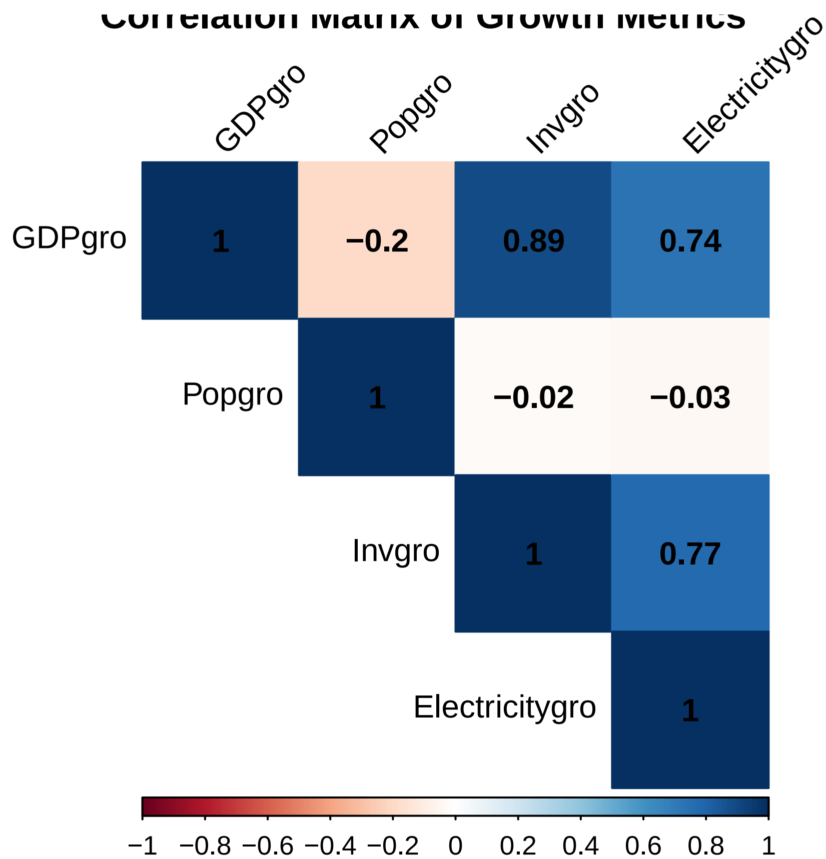
Explanation: 1: residuals from arima: The residuals are uncorrelated. The residuals have zero mean. 2: acf: The autocorrelation function is the correlation of the residuals (as a time series) with its own lags. There may be a correlation. 3: residuals 4: forecast: it is expected to fall in the short term but in the medium term ir will increase.

Summary and Conclusions

When examining the decomposed data, it is evident that yearly data do not exhibit seasonality. The graphs depicting GDP growth, investment growth, population growth, and electricity consumption growth do not display any upward or downward trends; instead, the data shows a horizontal and stationary pattern Positive relationships: There is a positive relationship between investment growth and GDP growth. There is a positive relationship between GDP growth and electricity consumption growth. There is a positive relationship between investment growth and electricity consumption growth. There is a negative relationship between population and GDP growth. There is no clear relationship between population and electricity consumption growth. There is no clear relationship between population and investment growth.

Regression Analysis

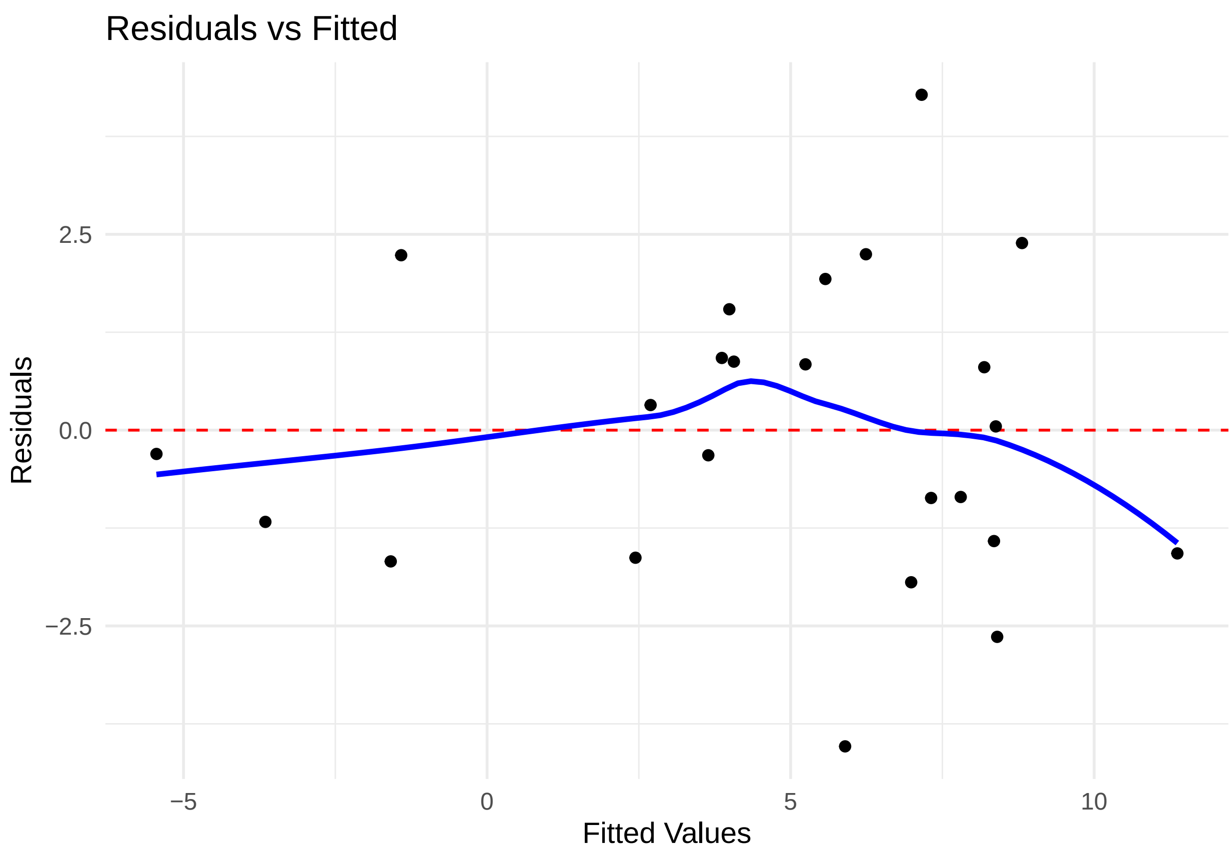
Correlation Matrix

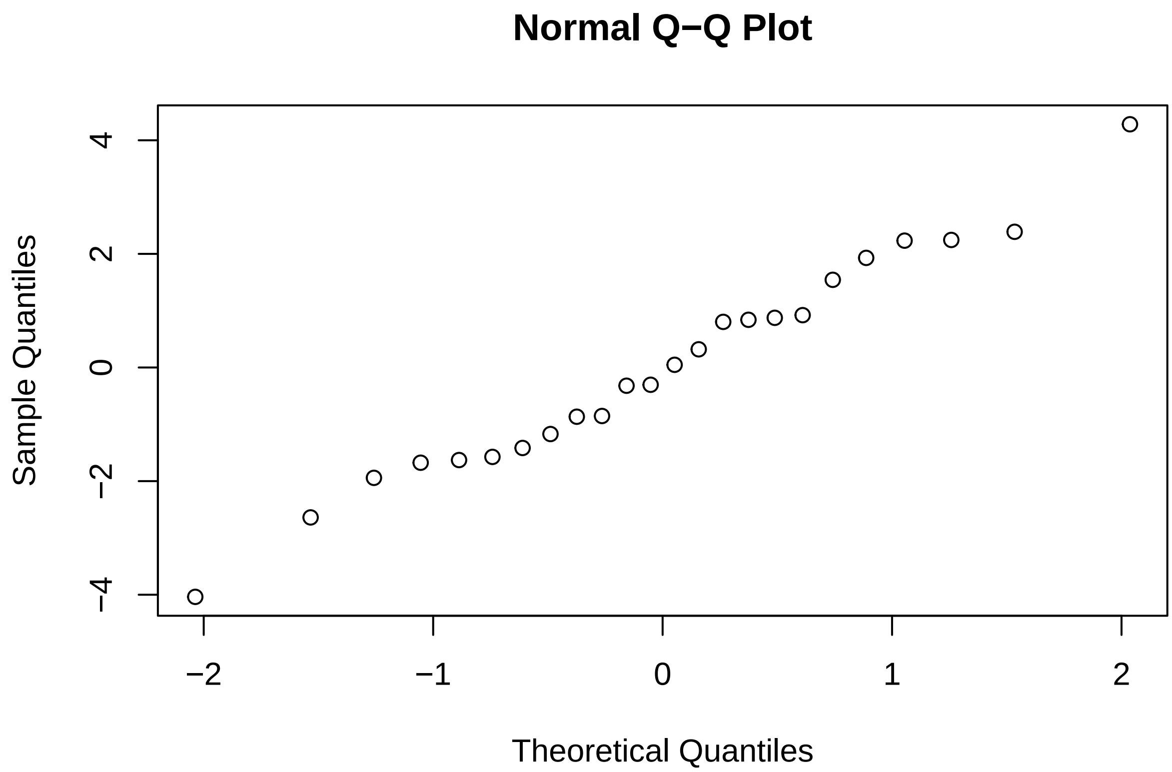


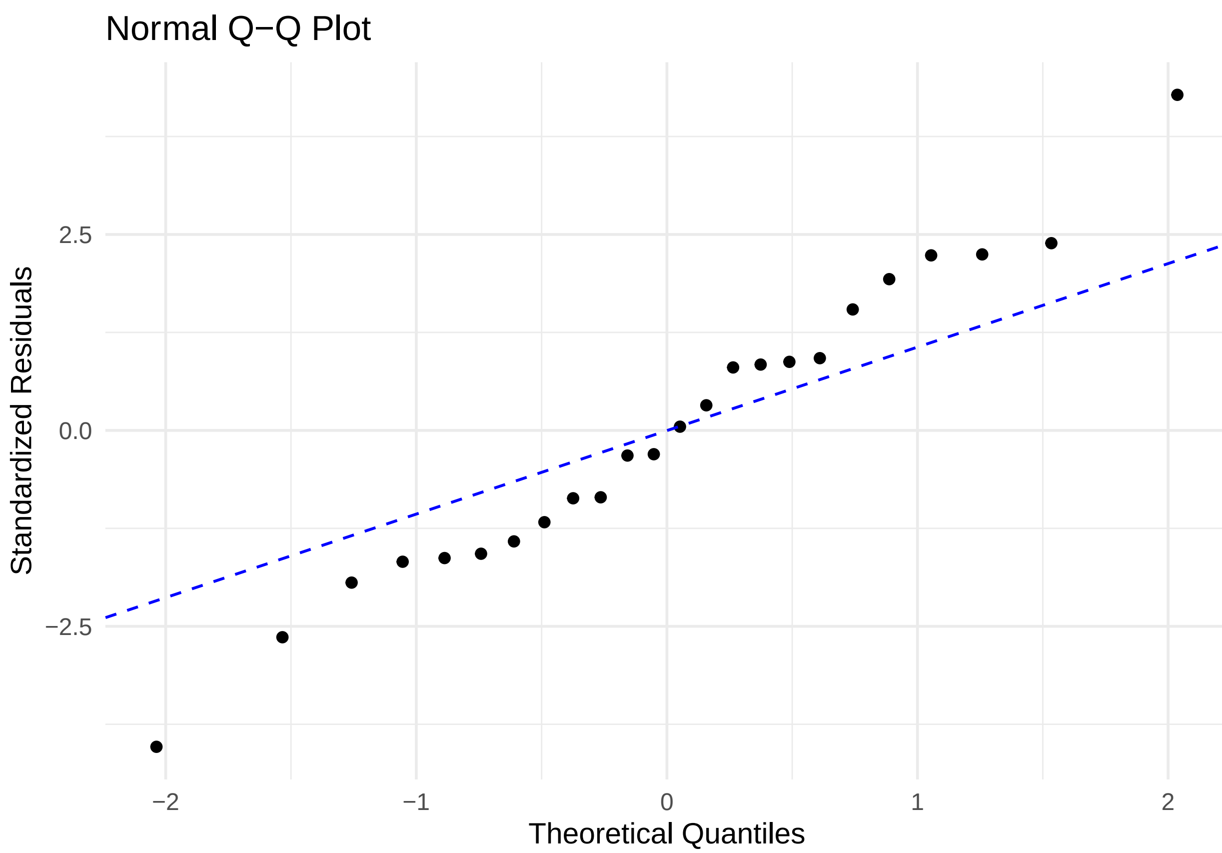
Explanation: The heatmap displays the correlation coefficients between GDP growth, population growth, investment growth, and electricity consumption growth in Turkiye. Dark blue indicates strong positive correlations, dark red signifies strong negative correlations, and lighter shades denote weaker relationships. Notably, investment growth and electricity consumption exhibit a strong positive correlation with GDP growth, while population growth shows a negligible relationship. This visual suggests that investment and electricity consumption are closely tied to economic performance.

regression plots

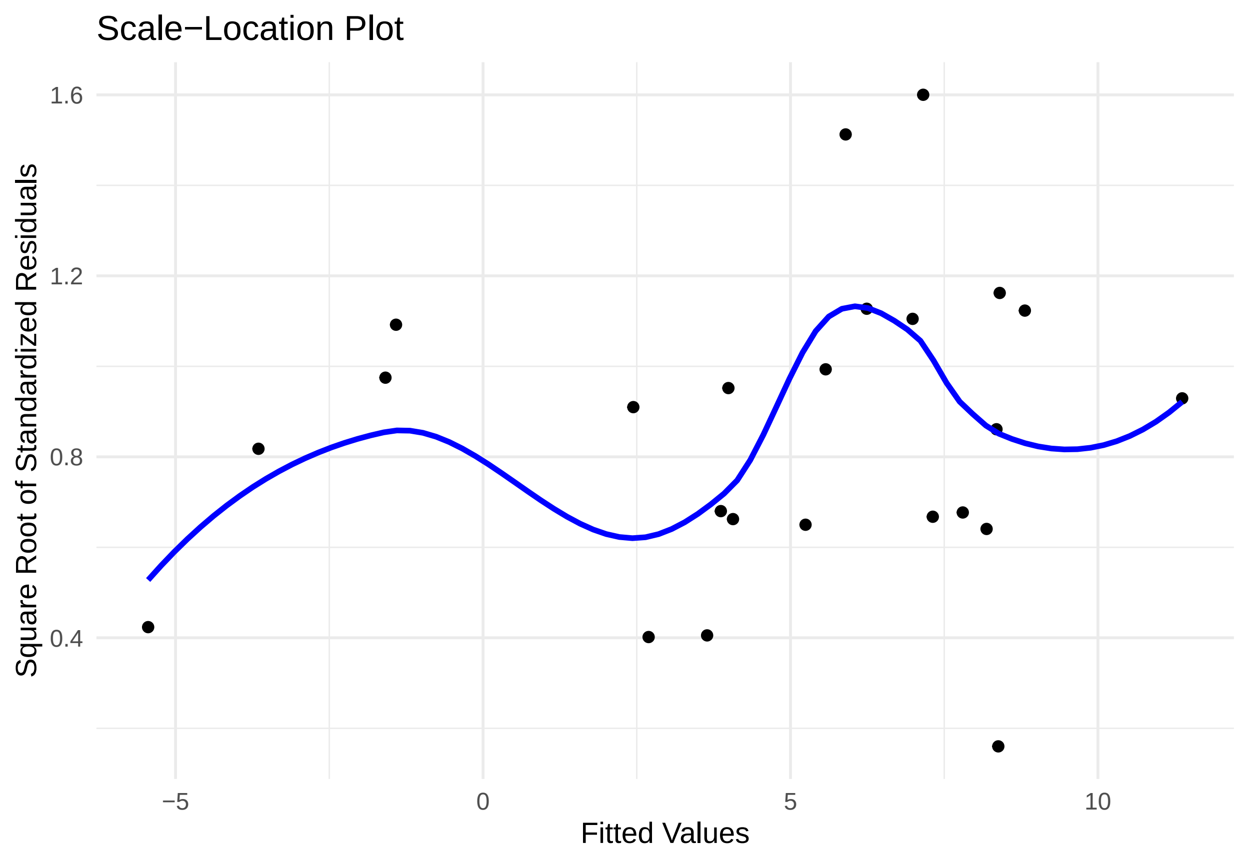
```
## `geom_smooth()` using formula = 'y ~ x'
```


Residuals vs Fitted
Residuals
2.5
0.0
−2.5
−5
0
5
10
Fitted Values

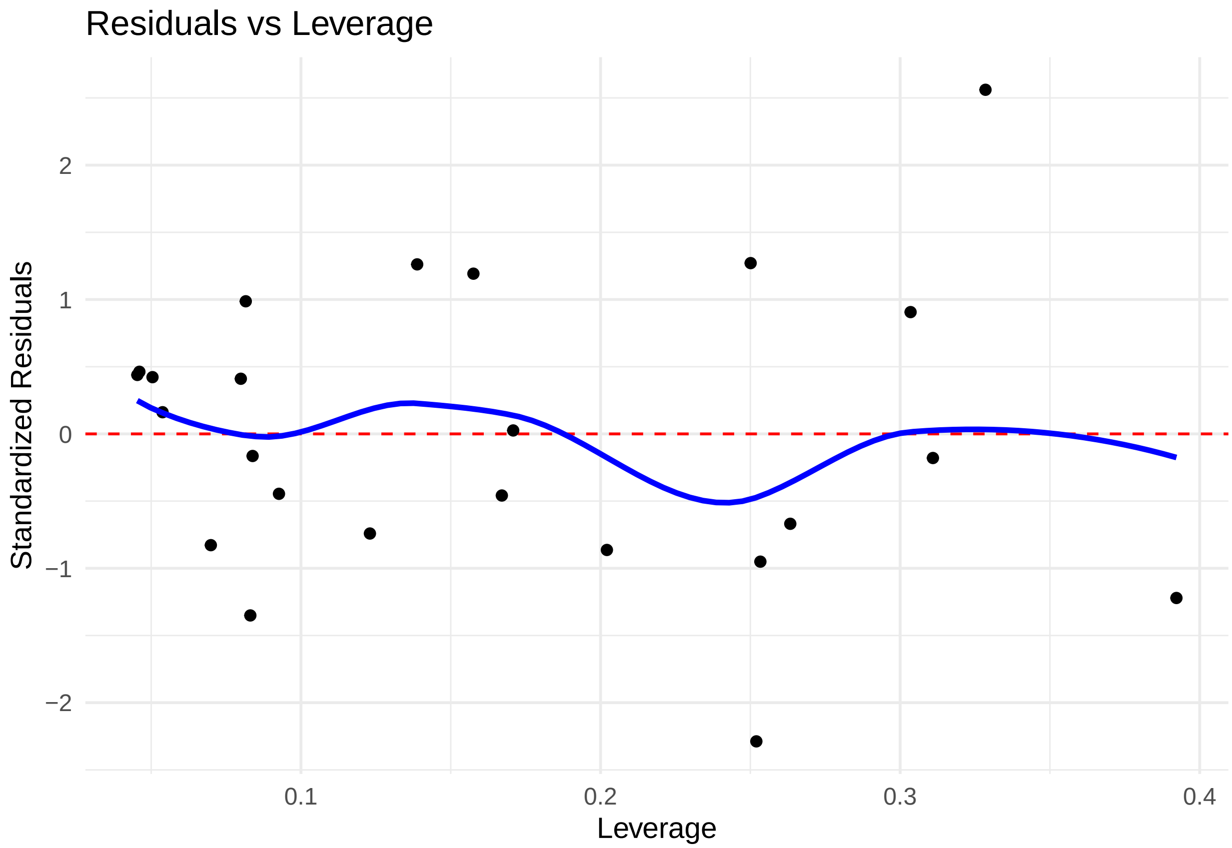

Normal Q−Q Plot
Sample Quantiles
Theoretical Quantiles
−4
−2
0
2
4
−2
−1
0
1
2




```
## `geom_smooth()` using formula = 'y ~ x'
```



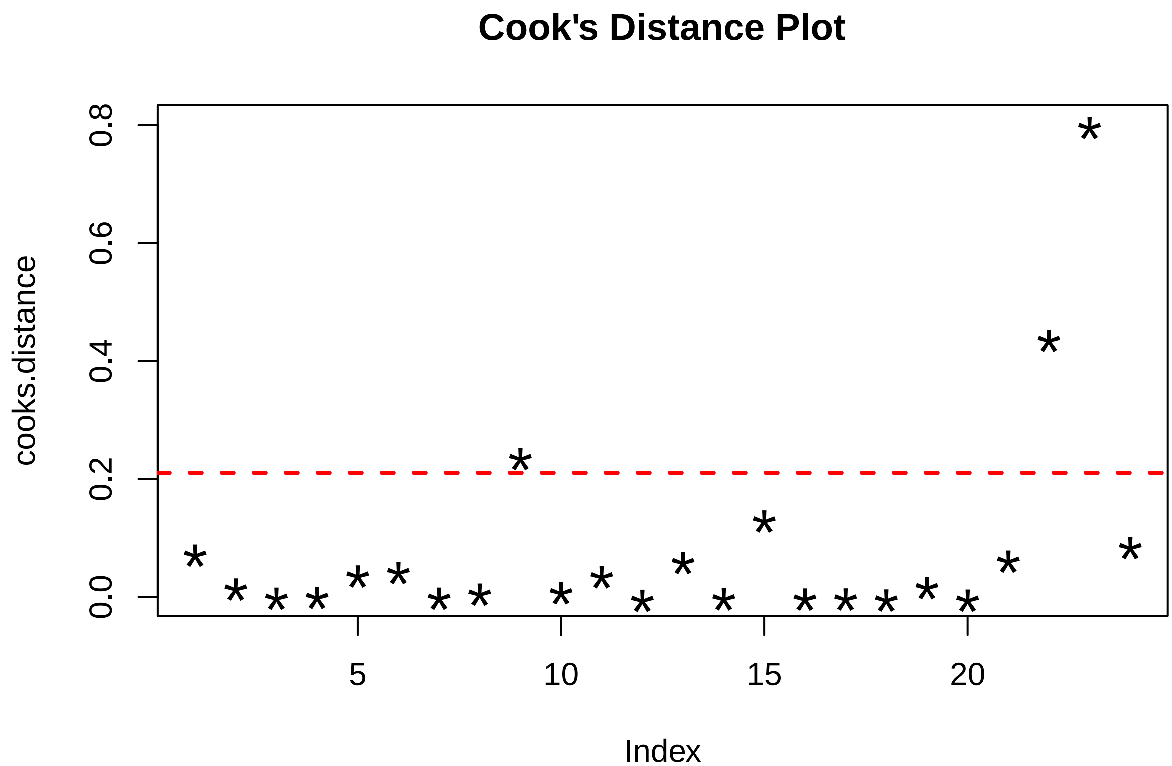

```
## `geom_smooth()` using formula = 'y ~ x'
```



Explanation: These plots suggest that while the model fits to some degree, there are indications of non-linearity, potential heteroscedasticity, and influential points, all of which could affect the reliability of the regression model. 1. Residuals vs Fitted Plot: It reveals the residuals' spread against the predicted values (fitted values). The red dashed line at y=0 represents the expectation where residuals would lie if the model's predictions were perfect. The blue line shows a non-linear relationship suggesting the presence of non-linearity in the model. 2.Normal Q-Q Plot: This plot is a graphical technique for determining if two data sets come from populations with a common distribution, in this case, if the residuals are normally distributed. Points deviating from the dashed line indicate departures from normality. 3.Scale-Location Plot: It shows the spread of residuals, allowing us to check the assumption of equal variance (homoscedasticity). It seems that the residuals spread out in a non-constant manner against the fitted values, indicating potential heteroscedasticity.

Cook's Distance

```
##   9  22  23
##   9  22  23
```



Explanation: In this plot, while most points are within acceptable bounds, a few points significantly exceed the threshold, indicating they are outliers with substantial influence on the model.

Conclusion

By identifying and addressing outliers, we improve the model's accuracy and reliability, providing a sound basis for economic insights and decisions. Our analysis is based on the assumption that while most data points conform to a general trend, some may deviate due to various factors. Cook's distance is a measure used to identify these influential outliers within the regression context.

The Cook's Distance Plot shown illustrates the influence of each data point in a regression analysis. Data points with higher Cook's Distance values are more influential, meaning they have a greater effect on the calculated regression line. The red dashed line represents a commonly used threshold; data points above this line are considered to have a significant impact and could potentially be outliers.

We use Cook's Distance to identify such influential points because if they are the result of errors or special conditions not applicable to the rest of the dataset, they can distort the results of the analysis. Recognizing these points allows an analyst to make informed decisions about whether to include them in the analysis, which can lead to a more accurate and reliable model. In your plot, several points exceed the threshold, indicating they are influential and should be assessed further to maintain the integrity of your regression results. In our plot, several points exceed the threshold, indicating they are influential and should be assessed further to maintain the integrity of our regression results.