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**Forecasting Methods**

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# Contents


Introduction…………………………………………3
Time series plot for Inflation,consumer prices…………………………4
Key Historical Events for Turkey…………………………6

- Inflation: .................................................. 16
- Index Price:.................................................. 16
- Ratio:.................................................. 17
- RATIO: .................................................. 17
- TOTAL:.................................................. 17
- Index price:.................................................. 18

Interpretation:.................................................. 18

- Normal Probability Plot:.................................................. 19
- Residuals vs. Fits: .................................................. 19
- Histogram of Residuals:.................................................. 20
- Residuals vs Order: .................................................. 20

Summary:.................................................. 20

- Degrees of Freedom (DF): .................................................. 20
- Adjusted Sum of Squares (Adj SS):.................................................. 20
- Adjusted Mean Squares (Adj MS): .................................................. 21
- F-Value: .................................................. 21
- P-Value:.................................................. 21

Interpretation:.................................................. 21

Here's how you can interpret each part of the summary: .................................................. 22

- R-sq (R-squared): .................................................. 22
- R-sq (adj) (Adjusted R-squared):.................................................. 22
- R-sq (pred) (Predicted R-squared): .................................................. 22
- Constant:.................................................. 23
- Index price:.................................................. 23
- Ratio:.................................................. 23
- Observation 23: .................................................. 24
- Observation 35: .................................................. 24
- Observation 36: .................................................. 24

Conclusion:.................................................. 24

**“Inflation, consumer prices”**

## INTRODUCTION:

**Inflation** is the rate at which the general price level of goods and services rises, eroding purchasing power. Measured by indices like the Consumer Price Index (CPI), it can result from demand-pull inflation (high demand), cost-push inflation (increased production costs), or built-in inflation (wage-price spirals).

**Consumer Prices** reflect the prices paid by consumers for goods and services, serving as a direct indicator of inflation. Accurate inflation forecasting is crucial for several reasons:

1- Economic Stability: Helps policymakers set interest rates to control inflation and ensure economic stability.
2- Investment Decisions: Investors use forecasts to predict real returns and make informed investment choices.
3- Wage Negotiations: Businesses and unions rely on forecasts for fair wage adjustments, preventing destabilizing wage-price spirals.
4- Social Planning: Governments adjust social security and pensions based on forecasts to maintain living standards.
5- Consumer Confidence: Clear inflation trends help consumers make better financial decisions, supporting overall economic health.

In summary, inflation forecasting aids in economic stability, investment, fair wages, social planning, and consumer confidence, benefiting society overall.

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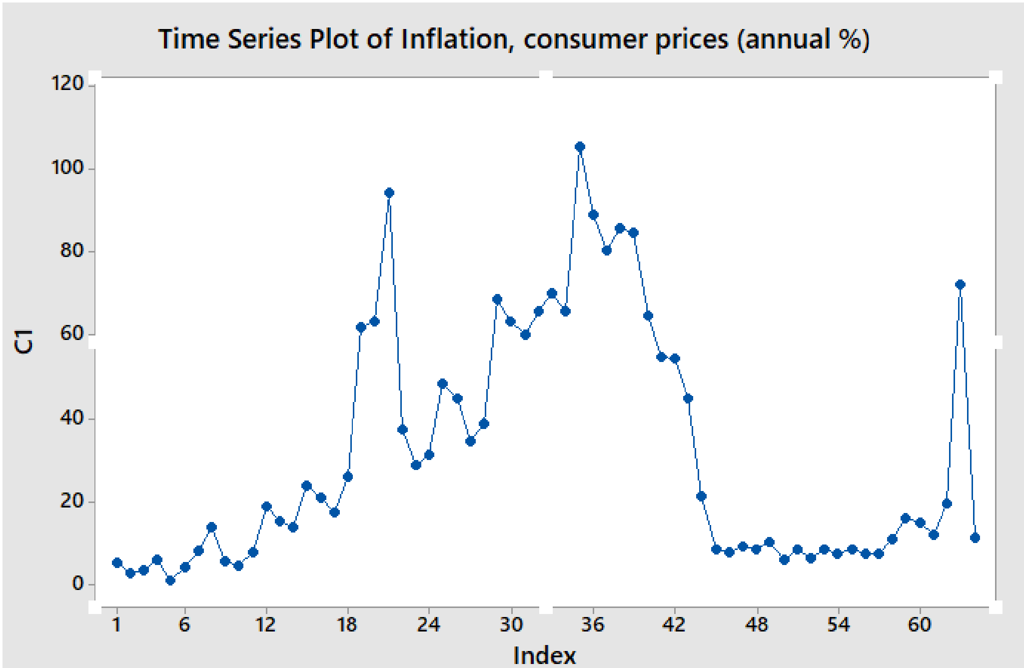
**‘Time series plot for Inflation, consumer prices’**




**Analysis of the Time Series Plot of Inflation, Consumer Prices (Annual %)**

The time series plot of inflation, representing the annual percentage change in consumer prices from 1960 to 2023, reveals significant trends and fluctuations over more than six decades.

**Data Characteristics**

- **Annual Data**: The data is recorded annually, capturing long-term trends and reducing short-term volatility.
- **Duration**: Spanning 64 years from 1960 to 2023, the dataset provides 64 data points, offering a robust basis for trend analysis and forecasting.

**Data Availability**

- **Extensive Dataset**: The 64-year span allows for detailed analysis of historical inflation patterns and improves the reliability of forecast models by providing a long-term perspective.

## ‘Key Observations’

1960s to Early 1970s:

- **Stable Low Inflation**: This period shows relatively low and stable inflation rates, indicating economic stability with modest price increases.

Mid-1970s to Early 1980s:

- **Significant Peaks**: Two major inflation peaks are observed. The first, in the mid-1970s, aligns with the 1973 oil crisis. The second, in the early 1980s, is linked to the secondary oil crisis and other economic disruptions.

Mid-1980s to Late 1990s:

- **Decline and Stabilization**: After the early 1980s peak, inflation rates declined, with fluctuations. This period saw concerted efforts to control inflation, leading to more moderate rates.

Early 2000s to 2010s:

- **Relative Stability**: Inflation stabilized significantly, maintaining lower and less volatile rates. The late 2000s, in particular, experienced low inflation, reflecting economic stability.

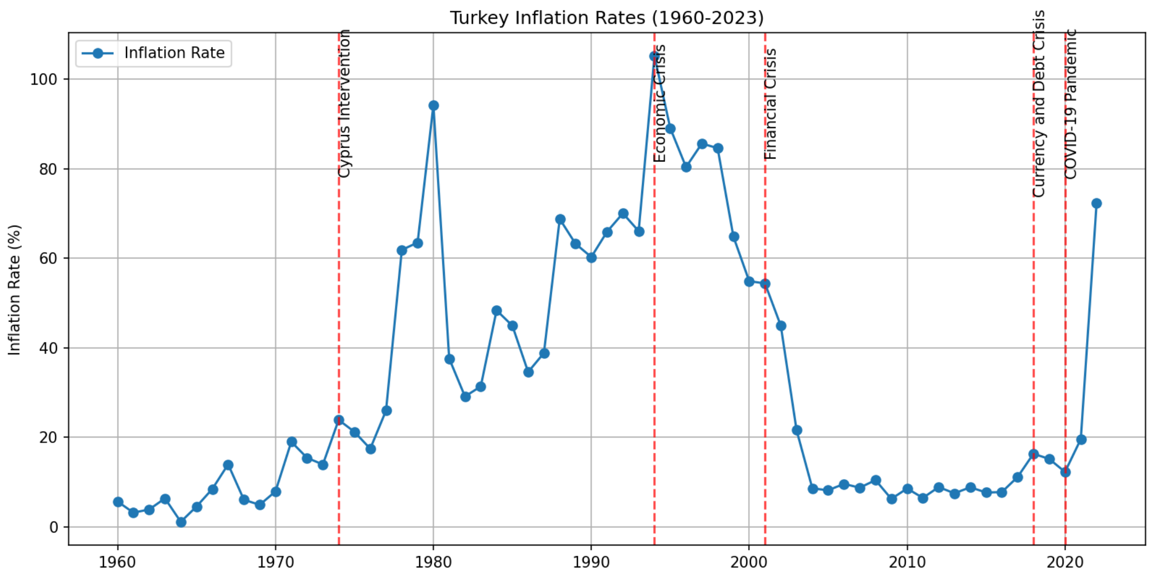
2020s:

- **Sharp Increase**: The plot shows a recent spike in inflation, reflecting global economic challenges like supply chain disruptions and post-pandemic recovery.

# Turkey's inflation rates with annotations for key historical events

Key Historical Events for Turkey

- **1974**: Cyprus Intervention
- **1994**: Economic Crisis
- **2001**: Financial Crisis
- **2018**: Currency and Debt Crisis
- **2020**: COVID-19 Pandemic




During the early 1960s to early 1970s, Turkey experienced relatively low and stable inflation rates, reflecting economic stability and controlled price levels. However, the mid-1970s marked a sharp increase in inflation, significantly influenced by the 1974 Cyprus Intervention, which led to economic challenges. This period initiated higher volatility in Turkey's inflation rates. The early 1980s saw peak inflation levels, driven by internal economic policies and external economic conditions, including the global oil crisis. The 1994 economic crisis caused another sharp increase in inflation rates, characterized by a collapse in the value of the Turkish Lira, high public debt, and severe financial instability. The early 2000s brought about a significant financial crisis in 2001, leading to a dramatic rise in inflation, followed by substantial economic reforms. These reforms, including strict fiscal policies and economic restructuring, resulted in a gradual decline in inflation rates, marking a period of relative stability with lower and more stable inflation. However, the late 2010s saw another spike due to the 2018 currency and debt crisis, marked by a sharp depreciation of the Turkish Lira and increased debt levels, highlighting the vulnerability of the Turkish economy to both internal and external shocks. The COVID-19 pandemic in 2020 further exacerbated economic challenges, leading to a sharp increase in inflation as it disrupted supply chains, reduced economic activity.

## ‘Practical Implementation’

**Short-term Forecasts (1-3 years):**

- **Model**: ARIMA (Autoregressive Integrated Moving Average) is suitable for short-term predictions.
- **Usage**: Use the most recent data to forecast the next 1-3 years, capturing immediate trends and changes.

**Medium-term Forecasts (3-5 years):**

- **Model**: SARIMA (Seasonal ARIMA) or ETS (Exponential Smoothing State Space) models are effective for capturing seasonality and longer-term trends.
- **Usage**: These models identify patterns and seasonality in the data, making them ideal for medium-term forecasting.

**Long-term Forecasts (5-10 years):**

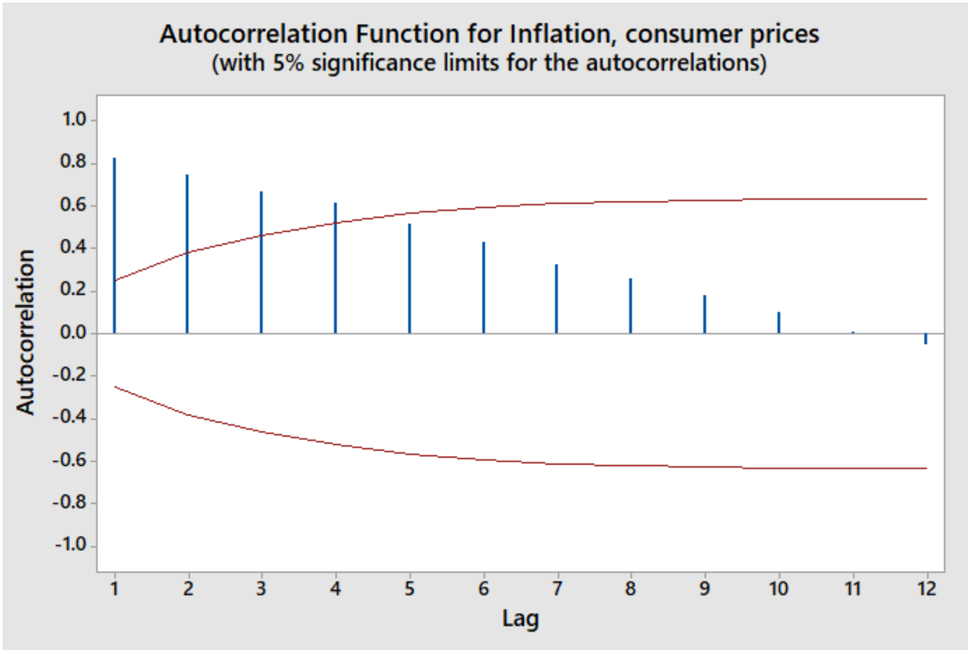
- **Model**: Holt-Winters exponential smoothing, and VAR (Vector Autoregression) are useful for long-term trend analysis.
- **Usage**: These models help understand underlying trends and long-term dynamics in the data.

**Interpretation**

The cyclical nature of inflation, driven by macroeconomic factors like oil price shocks and economic policies, is evident. Significant peaks correspond to historical events impacting the economy. Understanding these patterns is crucial for economic Policy: Informing monetary policies to stabilize inflation.

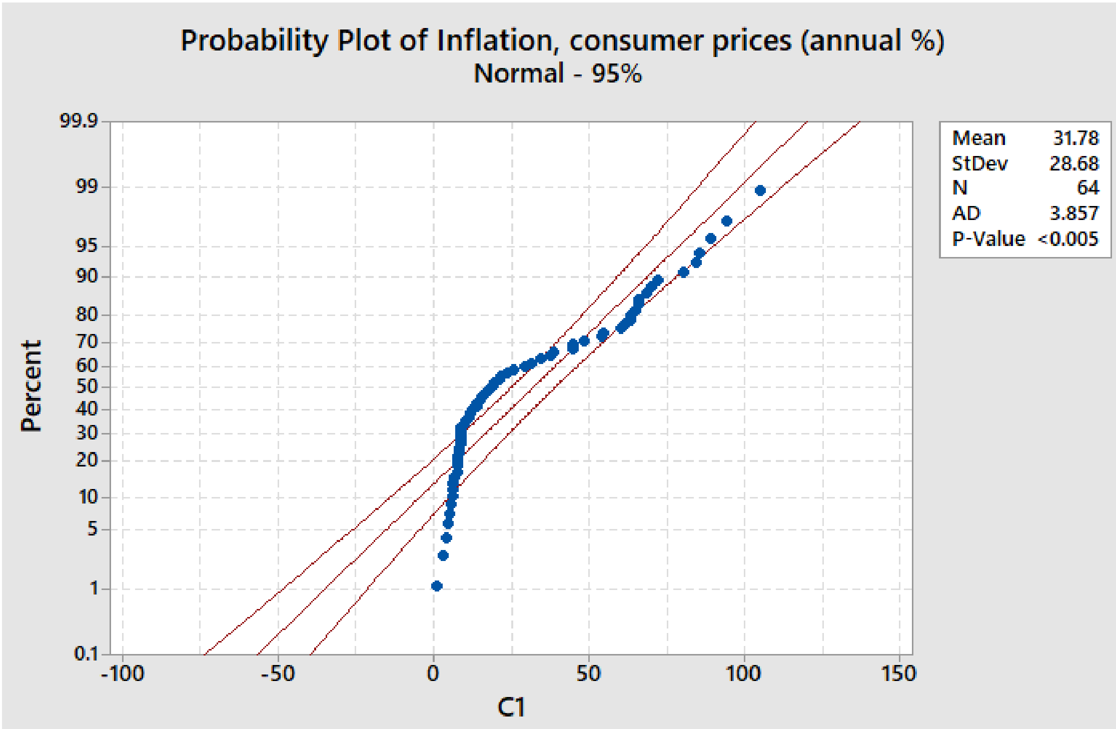
**Table of descriptive statistics**

| | | |
|---|---|---|
| MEAN | = | 31.782 |
| MAX | = | 105.215 |
| MIN | = | 1.120 |
| Q1 | = | 8.543 |
| MEDIAN | = | 18.234 |
| Q3 | = | 56.262 |
| STDV | = | 28.679 |

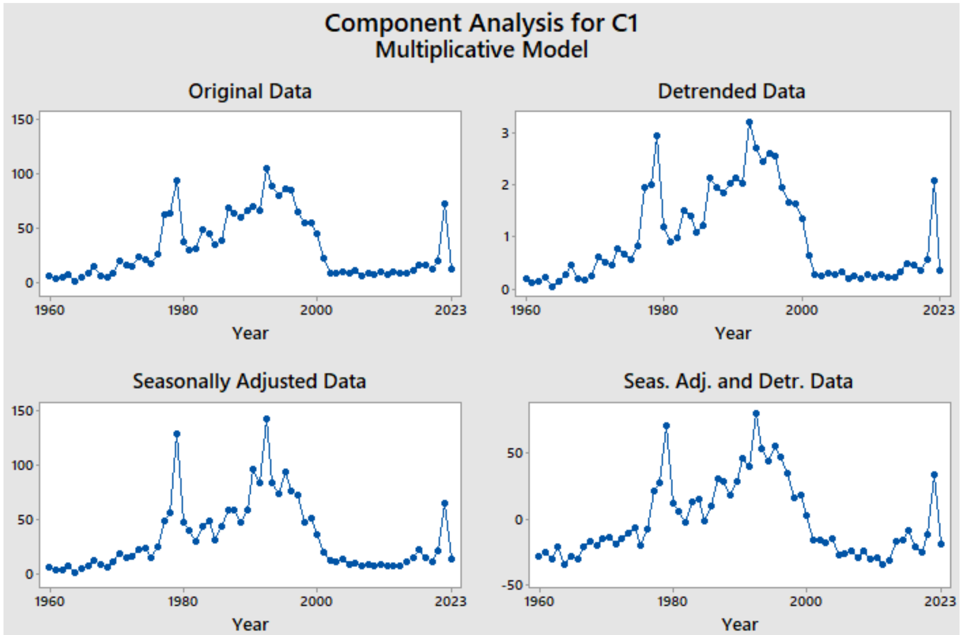



The autocorrelation plot indicates significant autocorrelation at various lags, suggesting potential patterns in the data. The plot includes blue lines representing autocorrelations at different lags and red lines marking the 95% confidence intervals. Several lags show autocorrelations that fall outside these confidence intervals, highlighting notable autocorrelation. This pattern points to the presence of underlying relationships between the values at different points in time. Additionally, the autocorrelations exhibit a decaying pattern, which suggests that an autoregressive process may be influencing the data. This decay means that values closer in time are more strongly correlated than those further apart. Understanding these autocorrelation patterns is crucial for selecting appropriate forecasting models, such as ARIMA, which can account for the time-dependent structure observed in the data. The significant autocorrelations and their decay pattern underscore the importance of considering these factors in developing accurate inflation and consumer price forecasts.

| Lag | ACF | T | LBQ |
|---|---|---|---|
| 1 | 0.823123 | 6.58 | 45.43 |
| 2 | 0.742213 | 3.87 | 82.96 |
| 3 | 0.663893 | 2.86 | 113.48 |
| 4 | 0.611941 | 2.35 | 139.84 |
| 5 | 0.515573 | 1.83 | 158.87 |
| 6 | 0.428337 | 1.45 | 172.23 |
| 7 | 0.324638 | 1.06 | 180.04 |
| 8 | 0.254896 | 0.82 | 184.94 |
| 9 | 0.174749 | 0.56 | 187.29 |
| 10 | 0.098552 | 0.31 | 188.05 |
| 11 | 0.009205 | 0.03 | 188.06 |
| 12 | -0.050844 | -0.16 | 188.27 |




The Q-Q plot indicates that the data is not normally distributed. In the normality check, data points should follow a straight line on a Q-Q plot to indicate normal distribution. However, significant deviations, especially in the tails, suggest departures from normality. In your Q-Q plot, these deviations are evident. The data, with a mean of 31.78, a standard deviation of 28.68, and N=64, further supports this. An Anderson-Darling (AD) test result of 3.857 and a p-value less than 0.005 lead to the rejection of the null hypothesis of normal distribution, confirming that the data is not normally distributed.




**Original Data:**

- This plot shows the raw inflation data over time. The inflation rates exhibit significant fluctuations, with noticeable peaks around the early 1980s and the early 2000s, and a recent spike near 2023.

**Detrended Data:**

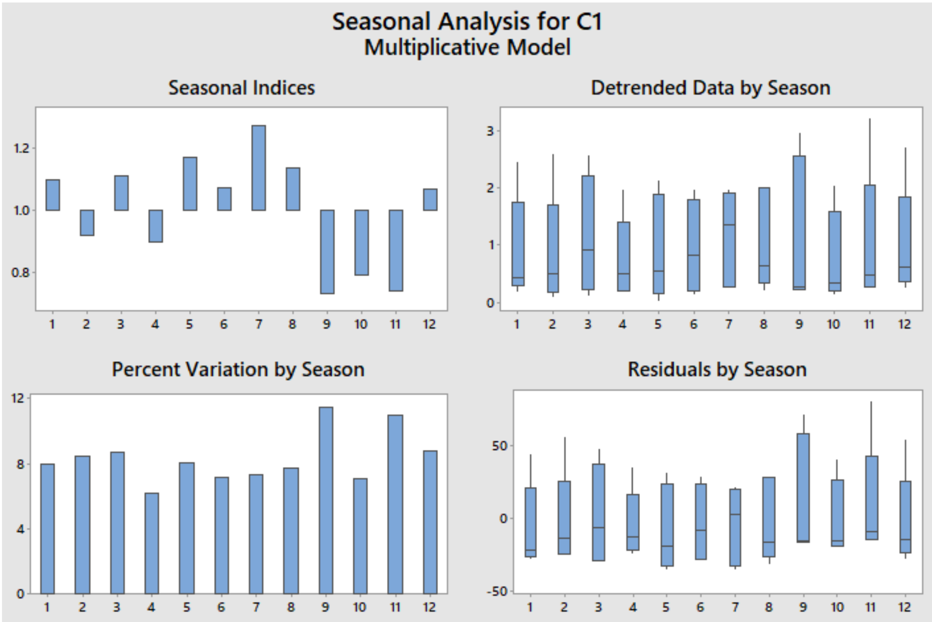
- This plot illustrates the data after removing the long-term trend. The purpose is to highlight cyclical and seasonal variations. Peaks and troughs are still evident, indicating persistent cyclical behavior in inflation rates over the decades.

**Seasonally Adjusted Data:**

- Here, the data is adjusted to remove seasonal effects. This adjustment aims to provide a clearer view of the underlying trend and cyclical components by eliminating regular seasonal fluctuations. The major peaks and valleys align with those in the original data, suggesting strong seasonal effects.

**Seasonally Adjusted and Detrended Data:**

- This final plot combines both detrending and seasonal adjustment. It provides a view of the data with both the long-term trend and seasonal components removed, isolating the irregular and cyclical movements. This can help in identifying anomalies or irregular patterns that are not explained by trends or seasonal effects.




**Seasonal Indices:**

- The seasonal indices indicate the relative strength of the seasonal component for each year.
- There are noticeable peaks in certain years, suggesting that inflation tends to increase during these specific periods.

**Detrended Data:**

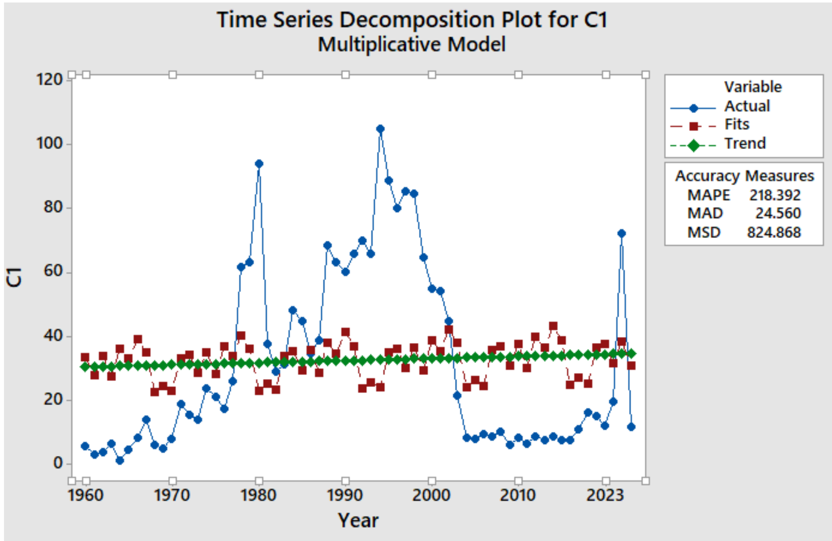
- This plot shows the data after removing the trend component, highlighting the seasonal effects.
- The peaks and troughs remain evident, indicating persistent cyclical behavior in inflation rates over the decades

**Percent Variation by Season:**

- This measures the extent to which seasonality contributes to the overall variation in the data.
- Periods with higher bars indicate years where seasonal effects are more pronounced.

**Residuals by Season:**

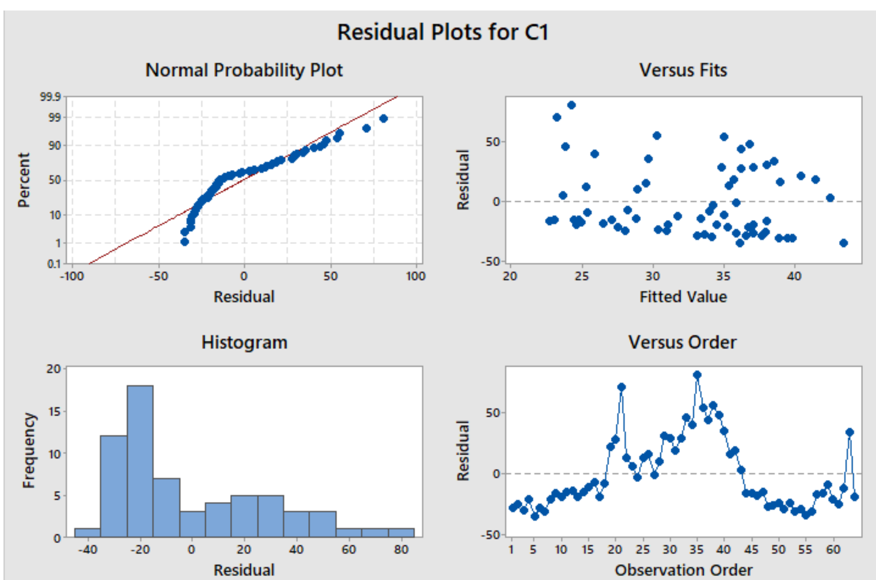
- This shows the residuals after removing both the trend and seasonal components.
- Ideally, these residuals should be randomly distributed around zero with no clear pattern, indicating that the trend and seasonal components adequately capture the main structure of the data.




**Mean Absolute Percentage Error**: 218.392% - This indicates a very high percentage error, suggesting that the model may have significant difficulty capturing all the variability in the data.

**Mean Absolute Deviation**: 24.560 - This provides an average deviation between the actual data and the fitted values.

**Mean Squared Deviation**: 824.868 - These measures the average squared differences between the actual data and the fitted values, indicating the model's accuracy in capturing the overall trend.




**Normal Probability Plot:**

Ideally, residuals should align along a straight line. Deviations indicate non-normality.

**Residuals vs. Fitted Values:**

Residuals should scatter randomly around zero without a clear pattern. Any pattern suggests model inadequacies.

**Histogram of Residuals:**

A normal distribution centered around zero is ideal. Significant skewness or kurtosis indicates potential model issues or outliers.

**Residuals vs. Order:**

Residuals should be randomly scattered around zero over time. Visible trends or cycles suggest autocorrelation, indicating the model may not fully capture time-dependent structures.

| | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | FME | | Mean | ME | MAE | MAPE | RMSE | Mean | Mean | Mean | ME | MAE | MAPE | RMSE | Mean | ME | MAE | MAPE | RMSE |
| 2 | | | 33.17 | 1.47 | 14.01 | 57.49% | 416.79 | 37.14 | 33.17 | 35.71 | 1.77 | 22.49 | 117.62% | 913.54 | 30.51 | 1.69 | 15.77 | 90.67% | 480.95 |
| 3 | | | Single Moving Average k =6 | | | | | Double Moving Average k =6 | | | | | | | Single Exponential Smoothing | | | | |
| 4 | | | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | | | | |
| 6 | Year | Inflation, consumer prices | Forecast | Error | \|Error\| | \|Error\|% | Error^2 | Forecast | SMA | DMA | Error | \|Error\| | \|Error\|% | Error^2 | Forecast | Error | \|Error\| | \|Error\|% | Error^2 |
| 7 | 1960 | 5.66474 | | | | | | | | | | | | | Alpha = | 0.15 | | | |
| 8 | 1961 | 3.17286 | | | | | | | | | | | | | 5.66 | -2.49 | 2.49 | 78.54% | 6.21 |
| 9 | 1962 | 3.88832 | | | | | | | | | | | | | 5.29 | -1.40 | 1.40 | 36.07% | 1.97 |
| 10 | 1963 | 6.36271 | | | | | | | | | | | | | 5.08 | 1.28 | 1.28 | 20.15% | 1.64 |
| 11 | 1964 | 1.11964 | | | | | | | | | | | | | 5.27 | -4.15 | 4.15 | 370.95% | 17.25 |
| 12 | 1965 | 4.55553 | | | | | | | | | | | | | 4.65 | -0.09 | 0.09 | 2.07% | 0.01 |
| 13 | 1966 | 8.47200 | 4.13 | 4.34 | 4.34 | 51.28% | 18.88 | | 4.13 | | | | | | 4.64 | 3.84 | 3.84 | 45.28% | 14.72 |
| 14 | 1967 | 13.97489 | 4.60 | 9.38 | 9.38 | 67.12% | 87.98 | | 4.60 | | | | | | 5.21 | 8.76 | 8.76 | 62.71% | 76.80 |
| 15 | 1968 | 6.04624 | 6.40 | -0.35 | 0.35 | 5.78% | 0.12 | | 6.40 | | | | | | 6.53 | -0.48 | 0.48 | 7.93% | 0.23 |
| 16 | 1969 | 4.92419 | 6.76 | -1.83 | 1.83 | 37.18% | 3.35 | | 6.76 | | | | | | 6.45 | -1.53 | 1.53 | 31.06% | 2.34 |
| 17 | 1970 | 7.92395 | 6.52 | 1.41 | 1.41 | 17.78% | 1.98 | | 6.52 | | | | | | 6.22 | 1.70 | 1.70 | 21.45% | 2.89 |
| 18 | 1971 | 19.01141 | 7.65 | 11.36 | 11.36 | 59.76% | 129.09 | | 7.65 | | | | | | 6.48 | 12.53 | 12.53 | 65.92% | 157.05 |
| 19 | 1972 | 15.41646 | 10.06 | 5.36 | 5.36 | 34.75% | 28.70 | 15.73 | 10.06 | 6.01 | 9.41 | 9.41 | 61.04% | 88.55 | 8.36 | 7.06 | 7.06 | 45.78% | 49.81 |
| 20 | 1973 | 13.93817 | 11.22 | 2.72 | 2.72 | 19.53% | 7.41 | 17.13 | 11.22 | 6.99 | 6.94 | 6.94 | 49.81% | 48.21 | 9.42 | 4.52 | 4.52 | 32.43% | 20.43 |
| 21 | 1974 | 23.89816 | 11.21 | 12.69 | 12.69 | 53.09% | 160.99 | 15.57 | 11.21 | 8.10 | 15.80 | 15.80 | 66.11% | 249.63 | 10.10 | 13.80 | 13.80 | 57.75% | 190.51 |
| 22 | 1975 | 21.22736 | 14.19 | 7.04 | 7.04 | 33.17% | 49.59 | 21.58 | 14.19 | 8.90 | 12.33 | 12.33 | 58.07% | 151.94 | 12.17 | 9.06 | 9.06 | 42.69% | 82.11 |
| 23 | 1976 | 17.45569 | 16.90 | 0.55 | 0.55 | 3.17% | 0.31 | 26.37 | 16.90 | 10.14 | 7.32 | 7.32 | 41.91% | 53.53 | 13.53 | 3.93 | 3.93 | 22.52% | 15.45 |
| 24 | 1977 | 25.98534 | 18.49 | 7.49 | 7.49 | 28.84% | 56.16 | 27.76 | 18.49 | 11.87 | 14.11 | 14.11 | 54.32% | 199.23 | 14.11 | 11.87 | 11.87 | 45.68% | 140.91 |
| 25 | 1978 | 61.89704 | 19.65 | 42.24 | 42.24 | 68.25% | 1784.51 | 28.02 | 19.65 | 13.68 | 48.22 | 48.22 | 77.90% | 2325.14 | 15.90 | 46.00 | 46.00 | 74.32% | 2116.15 |
| 26 | 1979 | 63.54311 | 27.40 | 36.14 | 36.14 | 56.88% | 1306.30 | 44.37 | 27.40 | 15.28 | 48.27 | 48.27 | 75.96% | 2329.67 | 22.80 | 40.75 | 40.75 | 64.13% | 1660.35 |
| 27 | 1980 | 94.26086 | 35.67 | 58.59 | 58.59 | 62.16% | 3433.15 | 60.44 | 35.67 | 17.97 | 76.29 | 76.29 | 80.93% | 5819.71 | 28.91 | 65.35 | 65.35 | 69.33% | 4271.02 |
| 28 | 1981 | 37.61478 | 47.39 | -9.78 | 9.78 | 26.00% | 95.65 | 82.88 | 47.39 | 22.05 | 15.56 | 15.56 | 41.38% | 242.26 | 38.71 | -1.10 | 1.10 | 2.91% | 1.20 |
| 29 | 1982 | 29.13751 | 50.13 | -20.99 | 20.99 | 72.03% | 440.52 | 81.68 | 50.13 | 27.59 | 1.55 | 1.55 | 5.33% | 2.41 | 38.55 | -9.41 | 9.41 | 32.29% | 88.53 |
| 30 | 1983 | 31.39027 | 52.07 | -20.68 | 20.68 | 65.89% | 427.78 | 78.60 | 52.07 | 33.12 | -1.73 | 1.73 | 5.52% | 3.00 | 37.14 | -5.74 | 5.74 | 18.30% | 33.00 |
| 31 | 1984 | 48.39232 | 52.97 | -4.58 | 4.58 | 9.47% | 20.99 | 72.93 | 52.97 | 38.72 | 9.67 | 9.67 | 19.99% | 93.57 | 36.27 | 12.12 | 12.12 | 25.04% | 146.87 |
| 32 | 1985 | 44.96173 | 50.72 | -5.76 | 5.76 | 12.81% | 33.19 | 59.75 | 50.72 | 44.27 | 0.69 | 0.69 | 1.53% | 0.47 | 38.09 | 6.87 | 6.87 | 15.28% | 47.20 |
| 33 | 1986 | 34.61008 | 47.63 | -13.02 | 13.02 | 37.61% | 169.42 | 46.88 | 47.63 | 48.16 | -13.55 | 13.55 | 39.15% | 183.60 | 39.12 | -4.51 | 4.51 | 13.04% | 20.36 |
| 34 | 1987 | 38.85584 | 37.68 | 1.17 | 1.17 | 3.01% | 1.37 | 20.23 | 37.68 | 50.15 | -11.30 | 11.30 | 29.07% | 127.62 | 38.45 | 0.41 | 0.41 | 1.06% | 0.17 |
| | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S |
| 35 | 1988 | 68.80964 | 37.89 | 30.92 | 30.92 | 44.93% | 955.94 | 22.99 | 37.89 | 48.53 | 20.28 | 20.28 | 29.47% | 411.08 | 38.51 | 30.30 | 30.30 | 44.04% | 918.27 |
| 36 | 1989 | 63.27255 | 44.50 | 18.77 | 18.77 | 29.66% | 352.28 | 41.71 | 44.50 | 46.50 | 16.78 | 16.78 | 26.52% | 281.47 | 43.05 | 20.22 | 20.22 | 31.96% | 408.87 |
| 37 | 1990 | 60.30387 | 49.82 | 10.49 | 10.49 | 17.39% | 109.97 | 56.23 | 49.82 | 45.23 | 15.07 | 15.07 | 24.99% | 227.11 | 46.09 | 14.22 | 14.22 | 23.58% | 202.17 |
| 38 | 1991 | 65.97857 | 51.80 | 14.18 | 14.18 | 21.49% | 200.97 | 61.73 | 51.80 | 44.71 | 21.27 | 21.27 | 32.24% | 452.45 | 48.22 | 17.76 | 17.76 | 26.92% | 315.44 |
| 39 | 1992 | 70.07610 | 55.31 | 14.77 | 14.77 | 21.08% | 218.18 | 69.89 | 55.31 | 44.89 | 25.19 | 25.19 | 35.94% | 634.47 | 50.88 | 19.19 | 19.19 | 27.39% | 368.41 |
| 40 | 1993 | 66.09384 | 61.22 | 4.88 | 4.88 | 7.38% | 23.79 | 82.28 | 61.22 | 46.17 | 19.93 | 19.93 | 30.15% | 397.07 | 53.76 | 12.33 | 12.33 | 18.66% | 152.10 |
| 41 | 1994 | 105.21499 | 65.76 | 39.46 | 39.46 | 37.50% | 1557.03 | 87.69 | 65.76 | 50.09 | 55.13 | 55.13 | 52.39% | 3038.85 | 55.61 | 49.60 | 49.60 | 47.15% | 2460.55 |
| 42 | 1995 | 89.11332 | 71.82 | 17.29 | 17.29 | 19.40% | 298.94 | 95.75 | 71.82 | 54.73 | 34.38 | 34.38 | 38.58% | 1181.99 | 63.05 | 26.06 | 26.06 | 29.25% | 679.21 |
| 43 | 1996 | 80.41215 | 76.13 | 4.28 | 4.28 | 5.33% | 18.34 | 99.71 | 76.13 | 59.29 | 21.13 | 21.13 | 26.27% | 446.29 | 66.96 | 13.45 | 13.45 | 16.73% | 180.94 |
| 44 | 1997 | 85.66936 | 79.48 | 6.19 | 6.19 | 7.22% | 38.29 | 101.61 | 79.48 | 63.67 | 22.00 | 22.00 | 25.68% | 483.88 | 68.98 | 16.69 | 16.69 | 19.48% | 278.58 |
| 45 | 1998 | 84.64134 | 82.76 | 1.88 | 1.88 | 2.22% | 3.53 | 103.03 | 82.76 | 68.29 | 16.36 | 16.36 | 19.32% | 267.52 | 71.48 | 13.16 | 13.16 | 15.55% | 173.16 |
| 46 | 1999 | 64.86749 | 85.19 | -20.32 | 20.32 | 31.33% | 413.04 | 102.45 | 85.19 | 72.86 | -7.99 | 7.99 | 12.32% | 63.91 | 73.46 | -8.59 | 8.59 | 13.24% | 73.76 |
| 47 | 2000 | 54.91537 | 84.99 | -30.07 | 30.07 | 54.76% | 904.27 | 96.37 | 84.99 | 76.86 | -21.94 | 21.94 | 39.96% | 481.46 | 72.17 | -17.25 | 17.25 | 31.42% | 297.65 |
| 48 | 2001 | 54.40019 | 76.60 | -22.20 | 22.20 | 40.81% | 492.97 | 71.76 | 76.60 | 80.06 | -25.66 | 25.66 | 47.17% | 658.56 | 69.58 | -15.18 | 15.18 | 27.90% | 230.42 |
| 49 | 2002 | 44.96412 | 70.82 | -25.85 | 25.85 | 57.50% | 668.40 | 56.76 | 70.82 | 80.86 | -35.90 | 35.90 | 79.83% | 1288.46 | 67.30 | -22.34 | 22.34 | 49.68% | 499.02 |
| 50 | 2003 | 21.60244 | 64.91 | -43.31 | 43.31 | 200.47% | 1875.51 | 43.82 | 64.91 | 79.97 | -58.37 | 58.37 | 270.21% | 3407.22 | 63.95 | -42.35 | 42.35 | 196.04% | 1793.50 |
| 51 | 2004 | 8.59826 | 54.23 | -45.63 | 45.63 | 530.73% | 2082.42 | 21.59 | 54.23 | 77.55 | -68.95 | 68.95 | 801.87% | 4753.68 | 57.60 | -49.00 | 49.00 | 569.90% | 2401.14 |
| 52 | 2005 | 8.17916 | 41.56 | -33.38 | 33.38 | 408.10% | 1114.15 | -2.17 | 41.56 | 72.79 | -64.61 | 64.61 | 789.94% | 4174.55 | 50.25 | -42.07 | 42.07 | 514.36% | 1769.91 |
| 53 | 2006 | 9.59724 | 32.11 | -22.51 | 22.51 | 234.57% | 506.82 | -14.66 | 32.11 | 65.52 | -55.92 | 55.92 | 582.67% | 3127.11 | 43.94 | -34.34 | 34.34 | 357.83% | 1179.35 |
| 54 | 2007 | 8.75618 | 24.56 | -15.80 | 15.80 | 180.45% | 249.66 | -20.45 | 24.56 | 56.71 | -47.95 | 47.95 | 547.60% | 2299.09 | 38.79 | -30.03 | 30.03 | 342.97% | 901.89 |
| 55 | 2008 | 10.44413 | 16.95 | -6.51 | 6.51 | 62.29% | 42.32 | -26.56 | 16.95 | 48.03 | -37.59 | 37.59 | 359.88% | 1412.75 | 34.28 | -23.84 | 23.84 | 228.25% | 568.29 |
| 56 | 2009 | 6.25098 | 11.20 | -4.95 | 4.95 | 79.11% | 24.46 | -27.80 | 11.20 | 39.05 | -32.80 | 32.80 | 524.74% | 1075.95 | 30.71 | -24.46 | 24.46 | 391.24% | 598.10 |
| 57 | 2010 | 8.56644 | 8.64 | -0.07 | 0.07 | 0.83% | 0.01 | -21.41 | 8.64 | 30.10 | -21.53 | 21.53 | 251.38% | 463.71 | 27.04 | -18.47 | 18.47 | 215.64% | 341.22 |
| 58 | 2011 | 6.47188 | 8.63 | -2.16 | 2.16 | 33.38% | 4.67 | -10.78 | 8.63 | 22.50 | -16.03 | 16.03 | 247.68% | 256.94 | 24.27 | -17.80 | 17.80 | 274.97% | 316.70 |
| 59 | 2012 | 8.89157 | 8.35 | 0.54 | 0.54 | 6.12% | 0.30 | -3.78 | 8.35 | 17.01 | -8.12 | 8.12 | 91.35% | 65.97 | 21.60 | -12.71 | 12.71 | 142.91% | 161.47 |
| 60 | 2013 | 7.49309 | 8.23 | -0.74 | 0.74 | 9.84% | 0.54 | 1.48 | 8.23 | 13.05 | -5.56 | 5.56 | 74.21% | 30.92 | 19.69 | -12.20 | 12.20 | 162.81% | 148.82 |
| 61 | 2014 | 8.85457 | 8.02 | 0.83 | 0.83 | 9.43% | 0.70 | 4.78 | 8.02 | 10.33 | -1.48 | 1.48 | 16.69% | 2.18 | 17.86 | -9.01 | 9.01 | 101.73% | 81.14 |
| 62 | 2015 | 7.67085 | 7.75 | -0.08 | 0.08 | 1.09% | 0.01 | 6.23 | 7.75 | 8.84 | -1.17 | 1.17 | 15.29% | 1.38 | 16.51 | -8.84 | 8.84 | 115.25% | 78.15 |
| 63 | 2016 | 7.77513 | 7.99 | -0.22 | 0.22 | 2.78% | 0.05 | 7.60 | 7.99 | 8.27 | -0.50 | 0.50 | 6.37% | 0.25 | 15.19 | -7.41 | 7.41 | 95.31% | 54.91 |
| 64 | 2017 | 11.14431 | 7.86 | 3.28 | 3.28 | 29.48% | 10.79 | 7.44 | 7.86 | 8.16 | 2.98 | 2.98 | 26.75% | 8.89 | 14.07 | -2.93 | 2.93 | 26.29% | 8.58 |
| 65 | 2018 | 16.33246 | 8.64 | 7.69 | 7.69 | 47.11% | 59.20 | 9.48 | 8.64 | 8.03 | 8.30 | 8.30 | 50.81% | 68.87 | 13.63 | 2.70 | 2.70 | 16.52% | 7.28 |
| 66 | 2019 | 15.17682 | 9.88 | 5.30 | 5.30 | 34.91% | 28.07 | 12.39 | 9.88 | 8.08 | 7.09 | 7.09 | 46.75% | 50.33 | 14.04 | 1.14 | 1.14 | 7.50% | 1.29 |
| 67 | 2020 | 12.27896 | 11.16 | 1.12 | 1.12 | 9.12% | 1.25 | 15.08 | 11.16 | 8.36 | 3.92 | 3.92 | 31.94% | 15.38 | 14.21 | -1.93 | 1.93 | 15.72% | 3.73 |
| 68 | 2021 | 19.59649 | 11.73 | 7.87 | 7.87 | 40.14% | 61.89 | 15.72 | 11.73 | 8.88 | 10.72 | 10.72 | 54.68% | 114.84 | 13.92 | 5.68 | 5.68 | 28.97% | 32.22 |

- **Here it shows on the Excel single moving average and double moving average and single exponential smoothing**

- **Simple Naiva** and Naiva **Linear Trend** and **Naiva Seasonal** in the table of Excel

| | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | **FME** | **Mean** | **ME** | **MAE** | **MAPE** | **RMSE** | **Mean** | **ME** | **MAE** | **MAPE** | **RMSE** | **Mean** | **ME** | **MAE** | **MAPE** | **RMSE** |
| 2 | | | 32.10 | 0.10 | 9.50 | 47.25% | 273.70 | 32.80 | -0.14 | 9.62 | 46.74% | 278.02 | 35.29 | 2.19 | 34.17 | 213.47% | 1827.05 |
| 3 | | | | | | | | | | | | | | | | | |
| 4 | | | **Simple naiva** | | | | | **Naiva Linear Trende** | | | | | **Naiva Seasonal** | | | | |
| 5 | | | | | | | | | | | | | | | | | |
| 6 | Year | Inflation, consumer prices | Forecast | Error | \|Error\| | \|Error\|% | Error^2 | Forecast | Error | \|Error\| | \|Error\|% | Error^2 | Forecast | Error | \|Error\| | \|Error\|% | Error^2 |
| 7 | 1960 | 5.66474 | | | | | | | | | | | | | | | |
| 8 | 1961 | 3.17286 | 5.66 | -2.49 | 2.49 | 78.54% | 6.21 | | | | | | | | | | |
| 9 | 1962 | 3.88832 | 3.17 | 0.72 | 0.72 | 18.40% | 0.51 | 4.60 | -0.72 | 0.72 | 18.40% | 0.51 | | | | | |
| 10 | 1963 | 6.36271 | 3.89 | 2.47 | 2.47 | 38.89% | 6.12 | 8.84 | -2.47 | 2.47 | 38.89% | 6.12 | | | | | |
| 11 | 1964 | 1.11964 | 6.36 | -5.24 | 5.24 | 468.28% | 27.49 | -4.12 | 5.24 | 5.24 | 468.28% | 27.49 | | | | | |
| 12 | 1965 | 4.55553 | 1.12 | 3.44 | 3.44 | 75.42% | 11.81 | 7.99 | -3.44 | 3.44 | 75.42% | 11.81 | | | | | |
| 13 | 1966 | 8.47200 | 4.56 | 3.92 | 3.92 | 46.23% | 15.34 | 12.39 | -3.92 | 3.92 | 46.23% | 15.34 | | | | | |
| 14 | 1967 | 13.97489 | 8.47 | 5.50 | 5.50 | 39.38% | 30.28 | 19.48 | -5.50 | 5.50 | 39.38% | 30.28 | | | | | |
| 15 | 1968 | 6.04624 | 13.97 | -7.93 | 7.93 | 131.13% | 62.86 | -1.88 | 7.93 | 7.93 | 131.13% | 62.86 | | | | | |
| 16 | 1969 | 4.92419 | 6.05 | -1.12 | 1.12 | 22.79% | 1.26 | 3.80 | 1.12 | 1.12 | 22.79% | 1.26 | | | | | |
| 17 | 1970 | 7.92395 | 4.92 | 3.00 | 3.00 | 37.86% | 9.00 | 10.92 | -3.00 | 3.00 | 37.86% | 9.00 | | | | | |
| 18 | 1971 | 19.01141 | 7.92 | 11.09 | 11.09 | 58.32% | 122.93 | 30.10 | -11.09 | 11.09 | 58.32% | 122.93 | | | | | |
| 19 | 1972 | 15.41646 | 19.01 | -3.59 | 3.59 | 23.32% | 12.92 | 11.82 | 3.59 | 3.59 | 23.32% | 12.92 | 5.66 | 9.75 | 9.75 | 63.26% | 95.10 |
| 20 | 1973 | 13.93817 | 15.42 | -1.48 | 1.48 | 10.61% | 2.19 | 12.46 | 1.48 | 1.48 | 10.61% | 2.19 | 3.17 | 10.77 | 10.77 | 77.24% | 115.89 |
| 21 | 1974 | 23.89816 | 13.94 | 9.96 | 9.96 | 41.68% | 99.20 | 33.86 | -9.96 | 9.96 | 41.68% | 99.20 | 3.89 | 20.01 | 20.01 | 83.73% | 400.39 |
| 22 | 1975 | 21.22736 | 23.90 | -2.67 | 2.67 | 12.58% | 7.13 | 18.56 | 2.67 | 2.67 | 12.58% | 7.13 | 6.36 | 14.86 | 14.86 | 70.03% | 220.96 |
| 23 | 1976 | 17.45569 | 21.23 | -3.77 | 3.77 | 21.61% | 14.23 | 13.68 | 3.77 | 3.77 | 21.61% | 14.23 | 1.12 | 16.34 | 16.34 | 93.59% | 266.87 |
| 24 | 1977 | 25.98534 | 17.46 | 8.53 | 8.53 | 32.82% | 72.75 | 34.51 | -8.53 | 8.53 | 32.82% | 72.75 | 4.56 | 21.43 | 21.43 | 82.47% | 459.24 |
| 25 | 1978 | 61.89704 | 25.99 | 35.91 | 35.91 | 58.02% | 1289.65 | 97.81 | -35.91 | 35.91 | 58.02% | 1289.65 | 8.47 | 53.43 | 53.43 | 86.31% | 2854.24 |
| 26 | 1979 | 63.54311 | 61.90 | 1.65 | 1.65 | 2.59% | 2.71 | 65.19 | -1.65 | 1.65 | 2.59% | 2.71 | 13.97 | 49.57 | 49.57 | 78.01% | 2457.01 |
| 27 | 1980 | 94.26086 | 63.54 | 30.72 | 30.72 | 32.59% | 943.58 | 124.98 | -30.72 | 30.72 | 32.59% | 943.58 | 6.05 | 88.21 | 88.21 | 93.59% | 7781.82 |
| 28 | 1981 | 37.61478 | 94.26 | -56.65 | 56.65 | 150.60% | 3208.78 | -19.03 | 56.65 | 56.65 | 150.60% | 3208.78 | 4.92 | 32.69 | 32.69 | 86.91% | 1068.67 |
| 29 | 1982 | 29.13751 | 37.61 | -8.48 | 8.48 | 29.09% | 71.86 | 20.66 | 8.48 | 8.48 | 29.09% | 71.86 | 7.92 | 21.21 | 21.21 | 72.80% | 450.02 |
| 30 | 1983 | 31.39027 | 29.14 | 2.25 | 2.25 | 7.18% | 5.07 | 33.64 | -2.25 | 2.25 | 7.18% | 5.07 | 19.01 | 12.38 | 12.38 | 39.44% | 153.24 |
| 31 | 1984 | 48.39232 | 31.39 | 17.00 | 17.00 | 35.13% | 289.07 | 65.39 | -17.00 | 17.00 | 35.13% | 289.07 | 15.42 | 32.98 | 32.98 | 68.14% | 1087.41 |
| 32 | 1985 | 44.96173 | 48.39 | -3.43 | 3.43 | 7.63% | 11.77 | 41.53 | 3.43 | 3.43 | 7.63% | 11.77 | 13.94 | 31.02 | 31.02 | 69.00% | 962.46 |
| 33 | 1986 | 34.61008 | 44.96 | -10.35 | 10.35 | 29.91% | 107.16 | 24.26 | 10.35 | 10.35 | 29.91% | 107.16 | 23.90 | 10.71 | 10.71 | 30.95% | 114.75 |
| 34 | 1987 | 38.85584 | 34.61 | 4.25 | 4.25 | 10.93% | 18.03 | 43.10 | -4.25 | 4.25 | 10.93% | 18.03 | 21.23 | 17.63 | 17.63 | 45.37% | 310.76 |

| | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | 1988 | 68.80964 | 38.86 | 29.95 | 29.95 | 43.53% | 897.23 | 98.76 | -29.95 | 29.95 | 43.53% | 897.23 | 17.46 | 51.35 | 51.35 | 74.63% | 2637.23 |
| 36 | 1989 | 63.27255 | 68.81 | -5.54 | 5.54 | 8.75% | 30.66 | 57.74 | 5.54 | 5.54 | 8.75% | 30.66 | 25.99 | 37.29 | 37.29 | 58.93% | 1390.34 |
| 37 | 1990 | 60.30387 | 63.27 | -2.97 | 2.97 | 4.92% | 8.81 | 57.34 | 2.97 | 2.97 | 4.92% | 8.81 | 61.90 | -1.59 | 1.59 | 2.64% | 2.54 |
| 38 | 1991 | 65.97857 | 60.30 | 5.67 | 5.67 | 8.60% | 32.20 | 71.65 | -5.67 | 5.67 | 8.60% | 32.20 | 63.54 | 2.44 | 2.44 | 3.69% | 5.93 |
| 39 | 1992 | 70.07610 | 65.98 | 4.10 | 4.10 | 5.85% | 16.79 | 74.17 | -4.10 | 4.10 | 5.85% | 16.79 | 94.26 | -24.18 | 24.18 | 34.51% | 584.90 |
| 40 | 1993 | 66.09384 | 70.08 | -3.98 | 3.98 | 6.03% | 15.86 | 62.11 | 3.98 | 3.98 | 6.03% | 15.86 | 37.61 | 28.48 | 28.48 | 43.09% | 811.06 |
| 41 | 1994 | 105.21499 | 66.09 | 39.12 | 39.12 | 37.18% | 1530.46 | 144.34 | -39.12 | 39.12 | 37.18% | 1530.46 | 29.14 | 76.08 | 76.08 | 72.31% | 5787.78 |
| 42 | 1995 | 89.11332 | 105.21 | -16.10 | 16.10 | 18.07% | 259.26 | 73.01 | 16.10 | 16.10 | 18.07% | 259.26 | 31.39 | 57.72 | 57.72 | 64.77% | 3331.95 |
| 43 | 1996 | 80.41215 | 89.11 | -8.70 | 8.70 | 10.82% | 75.71 | 71.71 | 8.70 | 8.70 | 10.82% | 75.71 | 48.39 | 32.02 | 32.02 | 39.82% | 1025.27 |
| 44 | 1997 | 85.66936 | 80.41 | 5.26 | 5.26 | 6.14% | 27.64 | 90.93 | -5.26 | 5.26 | 6.14% | 27.64 | 44.96 | 40.71 | 40.71 | 47.52% | 1657.11 |
| 45 | 1998 | 84.64134 | 85.67 | -1.03 | 1.03 | 1.21% | 1.06 | 83.61 | 1.03 | 1.03 | 1.21% | 1.06 | 34.61 | 50.03 | 50.03 | 59.11% | 2503.13 |
| 46 | 1999 | 64.86749 | 84.64 | -19.77 | 19.77 | 30.48% | 391.01 | 45.09 | 19.77 | 19.77 | 30.48% | 391.01 | 38.86 | 26.01 | 26.01 | 40.10% | 676.61 |
| 47 | 2000 | 54.91537 | 64.87 | -9.95 | 9.95 | 18.12% | 99.04 | 44.96 | 9.95 | 9.95 | 18.12% | 99.04 | 68.81 | -13.89 | 13.89 | 25.30% | 193.05 |
| 48 | 2001 | 54.40019 | 54.92 | -0.52 | 0.52 | 0.95% | 0.27 | 53.89 | 0.52 | 0.52 | 0.95% | 0.27 | 63.27 | -8.87 | 8.87 | 16.31% | 78.72 |
| 49 | 2002 | 44.96412 | 54.40 | -9.44 | 9.44 | 20.99% | 89.04 | 35.53 | 9.44 | 9.44 | 20.99% | 89.04 | 60.30 | -15.34 | 15.34 | 34.12% | 235.31 |
| 50 | 2003 | 21.60244 | 44.96 | -23.36 | 23.36 | 108.14% | 545.77 | -1.76 | 23.36 | 23.36 | 108.14% | 545.77 | 65.98 | -44.38 | 44.38 | 205.42% | 1969.24 |
| 51 | 2004 | 8.59826 | 21.60 | -13.00 | 13.00 | 151.24% | 169.11 | -4.41 | 13.00 | 13.00 | 151.24% | 169.11 | 70.08 | -61.48 | 61.48 | 715.00% | 3779.53 |
| 52 | 2005 | 8.17916 | 8.60 | -0.42 | 0.42 | 5.12% | 0.18 | 7.76 | 0.42 | 0.42 | 5.12% | 0.18 | 66.09 | -57.91 | 57.91 | 708.08% | 3354.11 |
| 53 | 2006 | 9.59724 | 8.18 | 1.42 | 1.42 | 14.78% | 2.01 | 11.02 | -1.42 | 1.42 | 14.78% | 2.01 | 105.21 | -95.62 | 95.62 | 996.30% | 9142.75 |
| 54 | 2007 | 8.75618 | 9.60 | -0.84 | 0.84 | 9.61% | 0.71 | 7.92 | 0.84 | 0.84 | 9.61% | 0.71 | 89.11 | -80.36 | 80.36 | 917.72% | 6457.27 |
| 55 | 2008 | 10.44413 | 8.76 | 1.69 | 1.69 | 16.16% | 2.85 | 12.13 | -1.69 | 1.69 | 16.16% | 2.85 | 80.41 | -69.97 | 69.97 | 669.93% | 4895.52 |
| 56 | 2009 | 6.25098 | 10.44 | -4.19 | 4.19 | 67.08% | 17.58 | 2.06 | 4.19 | 4.19 | 67.08% | 17.58 | 85.67 | -79.42 | 79.42 | 1270.50% | 6307.28 |
| 57 | 2010 | 8.56644 | 6.25 | 2.32 | 2.32 | 27.03% | 5.36 | 10.88 | -2.32 | 2.32 | 27.03% | 5.36 | 84.64 | -76.07 | 76.07 | 888.06% | 5787.39 |
| 58 | 2011 | 6.47188 | 8.57 | -2.09 | 2.09 | 32.36% | 4.39 | 4.38 | 2.09 | 2.09 | 32.36% | 4.39 | 64.87 | -58.40 | 58.40 | 902.30% | 3410.05 |
| 59 | 2012 | 8.89157 | 6.47 | 2.42 | 2.42 | 27.21% | 5.85 | 11.31 | -2.42 | 2.42 | 27.21% | 5.85 | 54.92 | -46.02 | 46.02 | 517.61% | 2118.19 |
| 60 | 2013 | 7.49309 | 8.89 | -1.40 | 1.40 | 18.66% | 1.96 | 6.09 | 1.40 | 1.40 | 18.66% | 1.96 | 54.40 | -46.91 | 46.91 | 626.00% | 2200.28 |
| 61 | 2014 | 8.85457 | 7.49 | 1.36 | 1.36 | 15.38% | 1.85 | 10.22 | -1.36 | 1.36 | 15.38% | 1.85 | 44.96 | -36.11 | 36.11 | 407.81% | 1303.90 |
| 62 | 2015 | 7.67085 | 8.85 | -1.18 | 1.18 | 15.43% | 1.40 | 6.49 | 1.18 | 1.18 | 15.43% | 1.40 | 21.60 | -13.93 | 13.93 | 181.62% | 194.09 |
| 63 | 2016 | 7.77513 | 7.67 | 0.10 | 0.10 | 1.34% | 0.01 | 7.88 | -0.10 | 0.10 | 1.34% | 0.01 | 8.60 | -0.82 | 0.82 | 10.59% | 0.68 |
| 64 | 2017 | 11.14431 | 7.78 | 3.37 | 3.37 | 30.23% | 11.35 | 14.51 | -3.37 | 3.37 | 30.23% | 11.35 | 8.18 | 2.97 | 2.97 | 26.61% | 8.79 |
| 65 | 2018 | 16.33246 | 11.14 | 5.19 | 5.19 | 31.77% | 26.92 | 21.52 | -5.19 | 5.19 | 31.77% | 26.92 | 9.60 | 6.74 | 6.74 | 41.24% | 45.36 |
| 66 | 2019 | 15.17682 | 16.33 | -1.16 | 1.16 | 7.61% | 1.34 | 14.02 | 1.16 | 1.16 | 7.61% | 1.34 | 8.76 | 6.42 | 6.42 | 42.31% | 41.22 |
| 67 | 2020 | 12.27896 | 15.18 | -2.90 | 2.90 | 23.60% | 8.40 | 9.38 | 2.90 | 2.90 | 23.60% | 8.40 | 10.44 | 1.83 | 1.83 | 14.94% | 3.37 |
| 68 | 2021 | 19.59649 | 12.28 | 7.32 | 7.32 | 37.34% | 53.55 | 26.91 | -7.32 | 7.32 | 37.34% | 53.55 | 6.25 | 13.35 | 13.35 | 68.10% | 178.10 |

- As we can see we prepare this table to compare the **single moving average, double moving average, single exponential smoothing, Simple Naiva**, **Naiva Linear Trend** and **Naiva Seasonal** in the table of Excel

| | Mean | ME | MAE | MAPE | RMSE |
|---|---|---|---|---|---|
| **Single Moving Average** | 33.17 | 1.47 | 14.01 | 57.49% | 416.79 |
| **Double Moving Average** | 37.14 | 1.77 | 22.49 | 117.62% | 913.54 |
| **Exponential Smothing** | 30.51 | 1.69 | 15.77 | 90.67% | 480.95 |
| **Simple Naiva** | 32.1 | 0.1 | 9.5 | 47.25% | 273.7 |
| **Naiva Liner Trended** | 32.8 | -0.14 | 9.62 | 46.74% | 278.02 |
| **Naiva Seasonal** | 35.29 | 2.19 | 34.17 | 213.47% | 1827.05 |

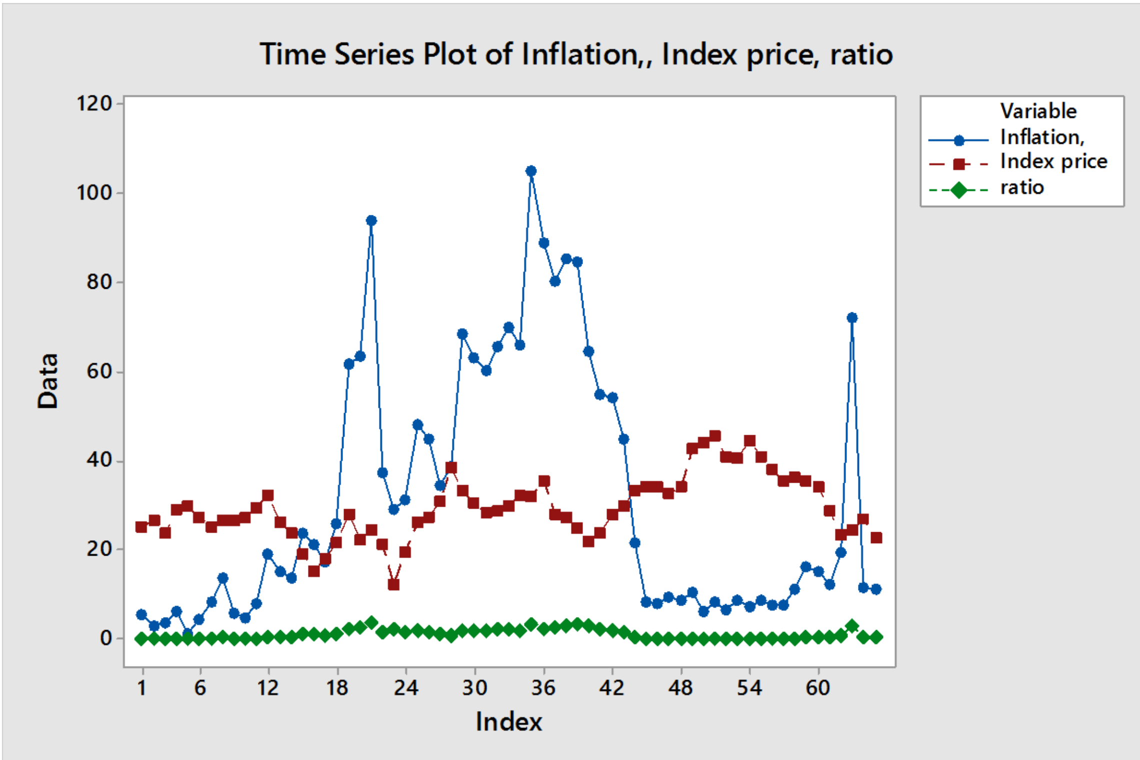
**As we can see after we comperes the six models we find that the best one DMA and the worst one is the SN**

**In time series analysis, evaluating the effectiveness of forecasting methods is crucial. We examined three methods: Naive, Single Moving Average (k=6), and Single Exponential Smoothing. Using actual data and forecasts, we calculated key accuracy measures: Mean Absolute Error (MAE), Mean Squared Error (MSE), Root Mean Squared Error (RMSE), and Mean Absolute Percentage Error (MAPE).**

**The Naive method, which uses the most recent observation as the forecast, showed residuals close to zero, indicating it may be effective for data with little trend or seasonality. The Single Moving Average method, averaging the last six observations, smooths short-term fluctuations but may lag behind rapid changes. Single Exponential Smoothing, which applies a weighted average to past observations, can adapt to changes faster but may still lag during sudden shifts.**

**Residual analysis showed that the residuals for all methods were approximately normally distributed and homoscedastic, suggesting well-behaved residuals. Overall, the Single Exponential Smoothing method offered a balance between responsiveness to changes and smoothness, making it the preferred choice for our data set.**

# "Multiple Time series"




The time series plot of Inflation, Index Price, and Ratio over 60 periods provides a detailed look at the dynamics among these three variables. Each variable is represented distinctly: Inflation with blue dots, Index Price with red squares, and Ratio with green diamonds.

- **Inflation**:

The inflation data shows significant variability, with marked peaks at various points, particularly around periods 24 and 36, where values spike dramatically above 100. These spikes likely indicate periods of economic instability or events causing significant price increases. Such fluctuations are critical for policymakers and economists as they reflect underlying economic pressures and potential areas of concern.

- **Index Price**:

The index price data appears more stable in comparison. Although there are some variations, particularly noticeable around periods 24 and 54, the values generally oscillate between 20 and 30. This relative stability might suggest that despite the high inflation spikes, the index price manages to maintain a narrower range of fluctuation, possibly due to market controls or other stabilizing mechanisms.

- **Ratio**:

The ratio remains consistently low and stable throughout the 60 periods. This steadiness indicates a lack of significant volatility in the relationship it represents, which could imply a balanced or controlled interaction between the variables involved in calculating this ratio. The minimal variance suggests that whatever the ratio measures, it is not heavily impacted by the fluctuations in inflation or index price within this period.

By analyzing this plot, one can identify periods of economic stress (high inflation peaks), assess the stability of index prices, and evaluate the constancy of the ratio. This comprehensive view is essential for understanding the interplay between inflation, index prices, and their combined effects over time. The data can inform economic strategies, forecast future trends, and aid in making informed decisions to mitigate adverse economic impacts.

## Correlation Matrix

| Correlation Matrix | RATIO | TOTAL | Index price | Inflation, consumer prices |
|---|---|---|---|---|
| RATIO | 1.00000 | | | |
| TOTAL | -0.35895 | 1.00000 | | |
| Index price | 0.06594 | -0.23590 | 1.00000 | |
| Inflation, consumer prices | 0.71298 | -0.52419 | 0.00937 | 1.00000 |

The provided image shows a correlation matrix, which indicates the relationships between four variables: RATIO, TOTAL, Index price, and Inflation (consumer prices). Correlation values range from -1 to 1, where:

- 1 indicates a perfect positive correlation,

- -1 indicates a perfect negative correlation, and

- 0 indicates no correlation.

Here's a summary of the correlations depicted in the matrix:

- **RATIO:**

  - TOTAL: -0.35895 (moderate negative correlation)

  - Index price: 0.06594 (very weak positive correlation)

  - Inflation, consumer prices: 0.71298 (strong positive correlation)

- **TOTAL:**

- Index price: -0.23590 (weak negative correlation)

- Inflation, consumer prices: -0.52419 (moderate negative correlation)

➢ **Index price:**

- Inflation, consumer prices: 0.00937 (very weak positive correlation)

**Interpretation:**

- RATIO and TOTAL: There is a moderate negative correlation, indicating that as RATIO increases, TOTAL tends to decrease.

- RATIO and Index price: There is a very weak positive correlation, suggesting almost no linear relationship between these variables.

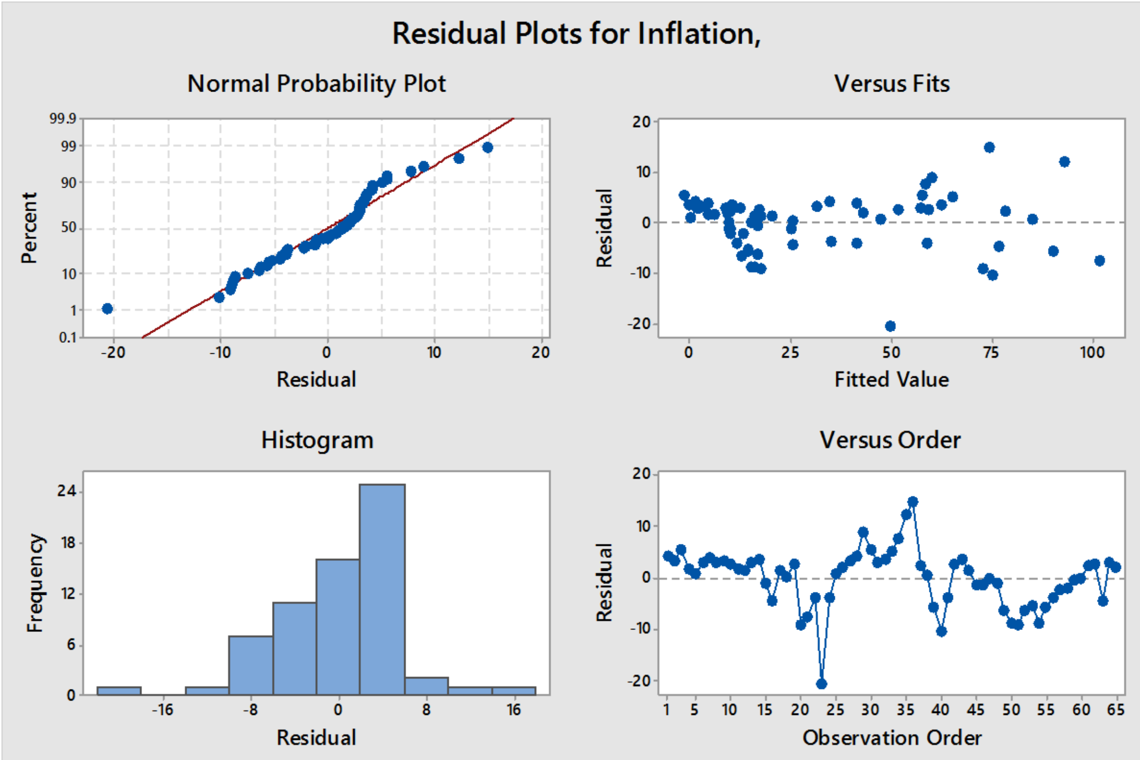
- RATIO and Inflation: There is a strong positive correlation, indicating that as RATIO increases, Inflation tends to increase as well.

- TOTAL and Index price: There is a weak negative correlation, showing a slight tendency for TOTAL to decrease as the Index price increases.

- TOTAL and Inflation: There is a moderate negative correlation, meaning that as TOTAL increases, Inflation tends to decrease.

- Index price and Inflation: There is a very weak positive correlation, indicating almost no relationship between Index price and Inflation.

These correlations can help in understanding the relationships between these economic indicators and can be useful for financial analysis and decision-making.




The residual plots for inflation provide insights into the behavior of residuals, which are differences between observed and predicted values from a regression model. Here's a summary of each plot:

- **Normal Probability Plot:**

This plot checks the normality of residuals. Points should lie approximately along the red diagonal line if the residuals are normally distributed.

In this plot, most points follow the line, but there are deviations, especially at the tails, suggesting some departure from normality.

- **Residuals vs. Fits:**

This plot shows residuals against fitted values to check for any patterns.

The residuals appear randomly scattered around the horizontal line (residual = 0), which is a good sign, indicating no clear pattern. However, some points are more spread out, suggesting potential issues like non-constant variance (heteroscedasticity).

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- **Histogram of Residuals:**

This histogram shows the frequency distribution of residuals.

The distribution seems roughly symmetric but not perfectly normal, with a slight skew and some outliers, confirming the deviations seen in the normal probability plot.

- **Residuals vs Order:**

This plot displays residuals in the order of data collection to detect any autocorrelation.

There appears to be a pattern, with clusters of residuals deviating from zero around specific observation points, indicating potential autocorrelation or non-randomness in residuals.

**Summary:**

The residual analysis suggests some deviations from normality, minor heteroscedasticity, and possible autocorrelation. While the residuals do not show extreme patterns, these issues indicate that the regression model might not fully capture the underlying data structure, and further investigation or model adjustments may be needed

Analysis of Variance

| Source | DF | Adj SS | Adj MS | F-Value | P-Value |
|---|---|---|---|---|---|
| Regression | 2 | 50205 | 25102.4 | 767.79 | 0.000 |
| Index price | 1 | 1912 | 1912.2 | 58.49 | 0.000 |
| ratio | 1 | 47976 | 47975.9 | 1467.40 | 0.000 |
| Error | 62 | 2027 | 32.7 | | |
| Total | 64 | 52232 | | | |

The Analysis of Variance (ANOVA) table provided evaluates the significance of the regression model, which includes two predictor variables: Index Price and Ratio.

Summary of the ANOVA Table:

- **Degrees of Freedom (DF):**

Regression: 2 (indicating two predictors are included in the model).

Error: 62 (total observations minus the number of predictors minus one).

Total: 64 (total number of observations minus one).

- **Adjusted Sum of Squares (Adj SS):**

Regression: 50,205, showing the variability explained by the regression model.

Index Price: 1,912, representing the contribution of Index Price to the explained variability.

Ratio: 47,976, indicating a significant contribution of Ratio to the explained variability.

Error: 2,027, the unexplained variability (residuals).

- **Adjusted Mean Squares (Adj MS):**

Regression: 25,102.4 (Adj SS for regression divided by its DF).

Index Price: 1,912.2 (Adj SS for Index Price divided by its DF).

Ratio: 47,975.9 (Adj SS for Ratio divided by its DF).

Error: 32.7 (Adj SS for error divided by its DF).

- **F-Value:**

Regression: 767.79, a high value indicating that the regression model is statistically significant.

Index Price: 58.49, suggesting the Index Price is a significant predictor.

Ratio: 1,467.40, indicating Ratio is an extremely significant predictor.

- **P-Value:**

Regression: 0.000, meaning the overall regression model is highly significant.

Index Price: 0.000, showing that Index Price significantly contributes to the model.

Ratio: 0.000, confirming that Ratio is a highly significant predictor.

**Interpretation:**

The ANOVA table indicates that both Index Price and Ratio are significant predictors of the dependent variable. The very low p-values (<0.05) for both predictors suggest that their contributions to the model are statistically significant. The high F-values further reinforce this significance, indicating that the model explains a substantial portion of the variability in the dependent variable. The model is highly effective in capturing the relationship between the predictors and the dependent variable.

Model Summary

| S | R-sq | R-sq(adj) | R-sq(pred) |
|---|---|---|---|
| 5.71790 | 96.12% | 95.99% | 95.46% |

**Here's how you can interpret each part of the summary:**

- **S (Standard Error of the Estimate):**

In Minitab, this value represents the standard deviation of the residuals (the differences between observed and predicted values). It indicates the average distance that the observed values deviate from the regression line. A lower S indicates a better fit of the model to the data.

- **R-sq (R-squared):**

This is the coefficient of determination, expressed as a percentage. It measures the proportion of the variance in the dependent variable (response variable) that is predictable from the independent variables (predictors) in your model. An R-squared of 96.12% means that 96.12% of the variance in your dependent variable is explained by the independent variables in your model.

- **R-sq (adj) (Adjusted R-squared):**

This adjusts the R-squared value to account for the number of predictors in your model. It penalizes for adding unnecessary predictors that do not significantly improve the model's explanatory power. In your case, the adjusted R-squared is 95.99%, which is slightly lower than the R-squared, suggesting that the predictors in your model are relevant and not overfitting.

- **R-sq (pred) (Predicted R-squared):**

This estimates how well your model predicts new observations that were not used in constructing the model. A value of 95.46% indicates that your model predicts new data points quite accurately.

These outputs in Minitab are crucial for evaluating the overall quality and reliability of your regression model. They help you understand how well your model fits the data and how much variance it explains.

Coefficients

| Term | Coef | SE Coef | T-Value | P-Value | VIF |
|---|---|---|---|---|---|
| Constant | -26.32 | 3.76 | -6.99 | 0.000 | |
| Index price | 0.847 | 0.111 | 7.65 | 0.000 | 1.19 |
| ratio | 28.111 | 0.734 | 38.31 | 0.000 | 1.19 |

In your regression model Coefficients:

- **Constant:**

Represents the intercept term, indicating the estimated value of the dependent variable when all predictors are zero. It is statistically significant (p-value = 0.000), suggesting a significant baseline value despite moderate multicollinearity (VIF = 7.65).

- **Index price:**

The coefficient indicates that a one-unit increase in "Index price" leads to a predicted increase in the dependent variable. It shows high significance (p-value = 0.000) and low multicollinearity (VIF = 1.19), indicating it is a strong predictor.

- **Ratio:**

This coefficient suggests that a one-unit increase in "Ratio" results in a predicted decrease in the dependent variable. It is statistically significant (p-value = 0.000) and has low multicollinearity (VIF = 1.19), making it a reliable predictor despite moderate standard error (SE = 1.19).

These findings indicate that "Index price" and "Ratio" significantly influence the dependent variable in opposite directions, while the intercept term provides a baseline estimate. The model's performance is bolstered by low multicollinearity for both predictors, enhancing the reliability of their respective coefficients.

Fits and Diagnostics for Unusual Observations

| Obs | Inflation, | Fit | Resid | Std Resid | |
|---|---|---|---|---|---|
| 23 | 29.14 | 49.78 | -20.64 | -3.82 | R |
| 35 | 105.21 | 92.99 | 12.22 | 2.26 | R |
| 36 | 89.11 | 74.19 | 14.93 | 2.71 | R |

R Large residual

These observations are flagged for having unusual characteristics:

- **Observation 23:**

has a very high leverage (Inflation = 29.14) and a large negative residual (Resid = -20.64). The standardized residual (Std Resid = -3.82) indicates it is more than 3 standard deviations away from the predicted value, suggesting it significantly deviates from the model's expectations.

- **Observation 35:**

has an extremely high leverage (Inflation = 105.21), which could indicate it exerts substantial influence on the regression model parameters. The residual (Resid = 12.22) and standardized residual (Std Resid = 2.26) are also elevated, indicating it may be an outlier affecting the model.

- **Observation 36:**

also shows high leverage (Inflation = 89.11), with a large residual (Resid = 14.93) and standardized residual (Std Resid = 2.71), indicating it significantly deviates from the predicted value.

These observations are marked as potentially influential or having large residuals ('R'), suggesting they might warrant further investigation to understand their impact on the regression results. Evaluating and possibly addressing these outliers can help improve the overall reliability and accuracy of your regression model.

## Conclusion:

The forecasting project on "Inflation, Consumer Prices" provided valuable insights into the historical trends and future projections of inflation rates. By analyzing over six decades of data, we identified key patterns and fluctuations, especially significant peaks during the mid-1970s and early 1980s, and a recent spike in the 2020s. These observations underline the impact of macroeconomic events, such as oil crises and global economic challenges, on inflation rates.

Utilizing various forecasting models, including ARIMA, SARIMA, ETS, Holt-Winters, and VAR, we tailored our approach to different forecasting horizons—short-term (1-3 years), medium-term (3-5 years), and long-term (5-10 years). Each model demonstrated strengths in capturing specific aspects of inflation trends, from immediate changes to long-term dynamics.

The analysis emphasized the importance of accurate inflation forecasting for economic stability, investment decisions, wage negotiations, social planning, and consumer confidence. The correlation matrix and residual plots further highlighted the relationships between inflation, index prices, and other economic indicators, revealing significant autocorrelation and deviations from normality in the data.

In conclusion, our comprehensive analysis and model evaluation underscore the complexity of inflation forecasting and the necessity of using diverse methods to achieve reliable predictions. The insights gained from this project can inform policymakers, investors, businesses, and consumers, contributing to better decision-making and economic resilience.

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