Forecasting - Final Assignment

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2 Executive Summary

This report presents the findings of a comprehensive analysis and evaluation of various forecasting methods applied to time series data from the M3 competition data set. The project aimed to explore the efficacy of different statistical models in accurately predicting future values of quarterly time series data, both through manual forecasting for individual series and batch forecasting for a range of series.

Through meticulous analysis and comparison, it became evident that the regression model stood out as the most accurate method in manual forecasting, surpassing both exponential smoothing with the Holt-Winters method and ARIMA models in terms of accuracy metrics. Moreover, during batch forecasting, evaluations of automatic ARIMA, automatic ETS, and TBATS models against Theta and Damped Exponential Smoothing models failed to surpass the latter in performance.

3 Introduction

Forecasting is a vital tool for decision-making across diverse domains. It enables organisations to anticipate future trends, allocate resources efficiently, and mitigate risks effectively. In practice, accurate forecasting is indispensable for strategic planning, inventory management, and market analysis.

This report delves into the practical aspects of forecasting by evaluating different statistical models applied to time series data. Time series forecasting, encompassing manual and batch approaches, is instrumental for businesses and organisations to optimise operations and capitalise on emerging opportunities.

The report focuses on analysing and forecasting quarterly time series data from the M3 competition data set, spanning various sectors such as finance, economics, and demographics. Each time series represents a historical record of a specific variable, such as sales numbers, stock prices, or production levels, recorded at regular intervals—yearly, quarterly, or monthly. By leveraging manual forecasting techniques for individual series and batch forecasting methods for multiple series simultaneously, this study aims to provide insights into the effectiveness of different forecasting methodologies.

According to Koning, Franses, Hibon and Stekler (2005), four main conclusions of the M3 competition were derived from descriptive statistics analysis with no formal statistical testing. First, the complexity of forecasting methods does not always correlate with forecast accuracy; simpler methods can be equally effective. Second, the performance rankings of different methods vary depending on the accuracy measure employed. Third, combining various forecasting methods tends to yield better results than using individual methods alone, demonstrating superior performance overall. Lastly, the effectiveness of forecasting methods is influenced by the length of the forecasting horizon.

4 Manual Modelling

4.1 Exploratory analysis

In this section, we focus on series ID 1394 from the M3 forecasting competition, which tracks quarterly demographic data, specifically unemployment in Canada. This time series is valuable for analysts and researchers studying labour market trends in Canada and could aid in developing forecasting models to predict future unemployment based on historical patterns. We assume the data has been adjusted to represent per capita data. A summary of series 1394 is provided below (R code 8.1).

```
Table 1: M3 competition series ID 1394

$st
[1] "Q749"

$type
[1] "DEMOGRAPHIC"
```

```
$period
[1] "QUARTERLY"

$description
[1] "UNEMPLOYMENT- CANADA"

$sn
[1] "N1394"

$x
     Qtr1 Qtr2 Qtr3 Qtr4
1962 5610 3730 2820 3460
1963 5460 3720 2720 3050
1964 4630 3260 2430 2660
1965 3970 2980 2100 2140
1966 3520 2580 2260 2330
1967 3920 3200 2500 2990
1968 4780 3990 3170 3330
1969 4630 4000 3150 3500
1970 5180 5290 4550 4780
1971 6640 5840 4680 4930
1972 6450 5710 5020 5300
1973 6500 5220 4380 4700

$xx
     Qtr1 Qtr2 Qtr3 Qtr4
1974 6240 5200 4480 5070
1975 8320 7380 6210 6380

$h
```

```
[1] 8


$n
[1] 48
```

Within the context of the M3 competition data set, 'x' serves as the historical (a.k.a. training) time series data from 1962 to 1973, which is used to develop and calibrate forecasting models, while 'xx' acts as the future (a.k.a. test) data set from 1974 to 1975, which is used to evaluate the performance and accuracy of the models' predictions.

Producing a time series plot of the historical data (Figure 1) and its summary will help gain insights into the data's characteristics (R code 8.2).

Figure 1: Quarterly unemployment in Canada in 1962-1973

```
Table 2: Summary of the quarterly unemployment in Canada in 1962-1973

   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
   2100    3035    3945    4037    4952    6640
```

The series exhibits a downward trend before 1966, followed by a clear upward trend starting in 1966, indicating an increase in the unemployed since then. A strong seasonal pattern is evident in Figure 2, with peaks and troughs corresponding to particular times of the year (Q1 and Q3, respectively) (Figure 3), suggesting likely annual seasonality influenced by various factors related to economic activity, societal habits, and institutional schedules (R code 8.3).

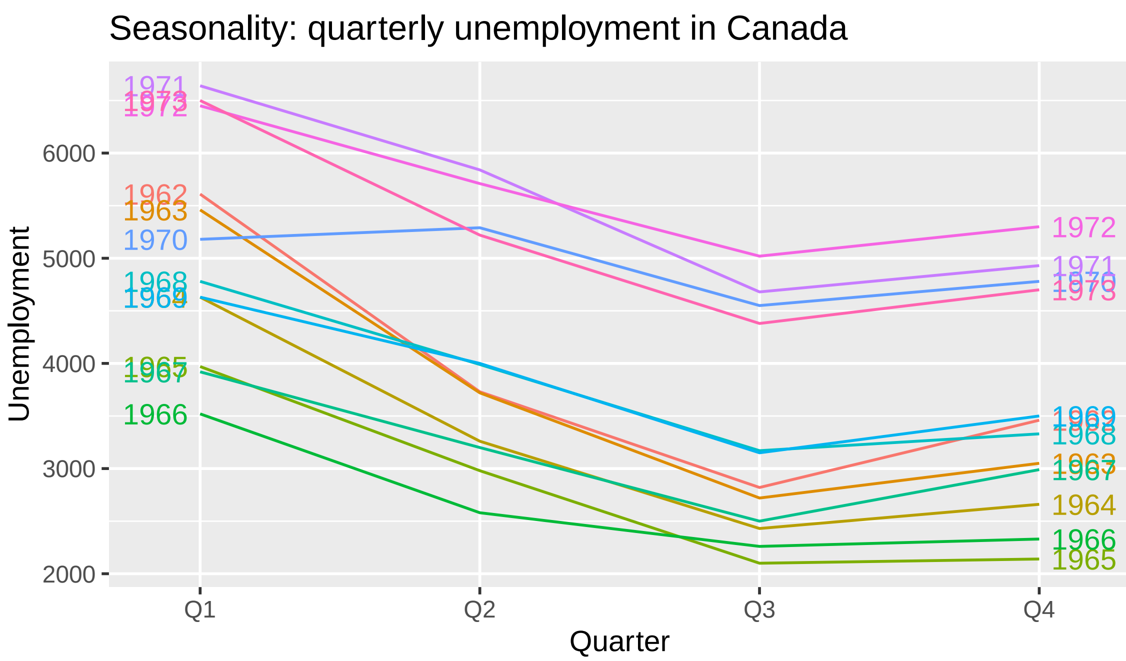

Figure 2: Seasonality plot of the quarterly unemployment in Canada in 1962-1973

The lagged scatter plots of the quarterly Canadian unemployment (Figure 4) reveal a strongly positive relationship at lag 4, reflecting the strong seasonality in the data (R code 8.4).

As the data are both trended and seasonal, we observe the slow decay in autocorrelation associated with the trend component alongside more significant spikes at lags matching the seasonal period in Figure 5 (R code 8.5).

As the data exhibits both trend and seasonality, decomposition can be a valuable insight by separating the time series into trend, seasonality, and residual components. Upon decomposing the time series, the multiplicative type of decomposition effectively subtracts the seasonal and trend-cycle components from the training data in Figure 6 (R code 8.6).

However, discerning longer-term cyclical fluctuations in Canada's unemployment due to

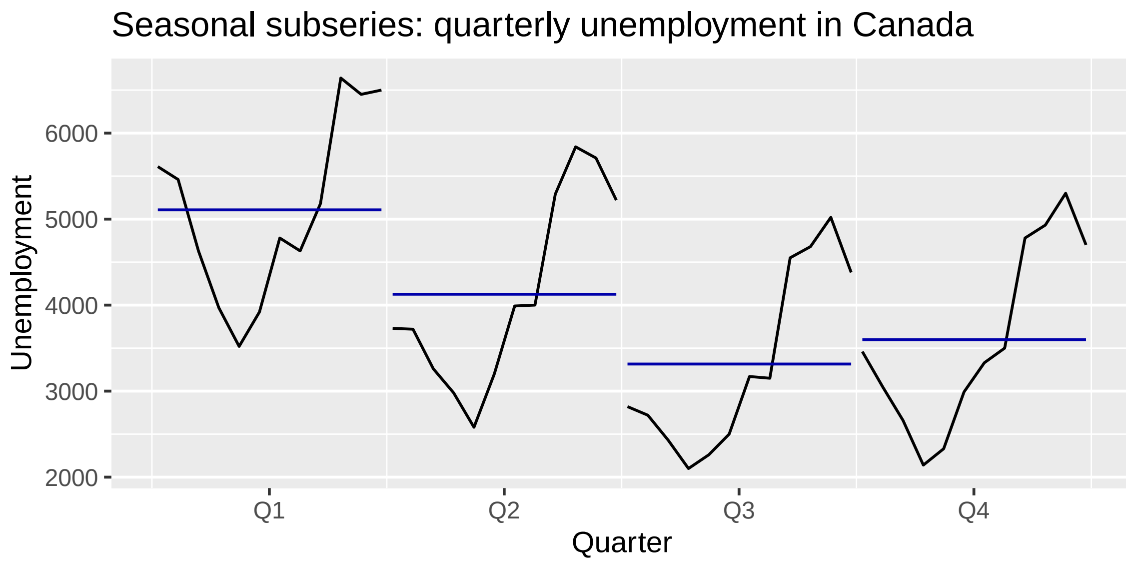

Figure 3: Seasonal subseries plot of the quarterly unemployment in Canada in 1962-1973

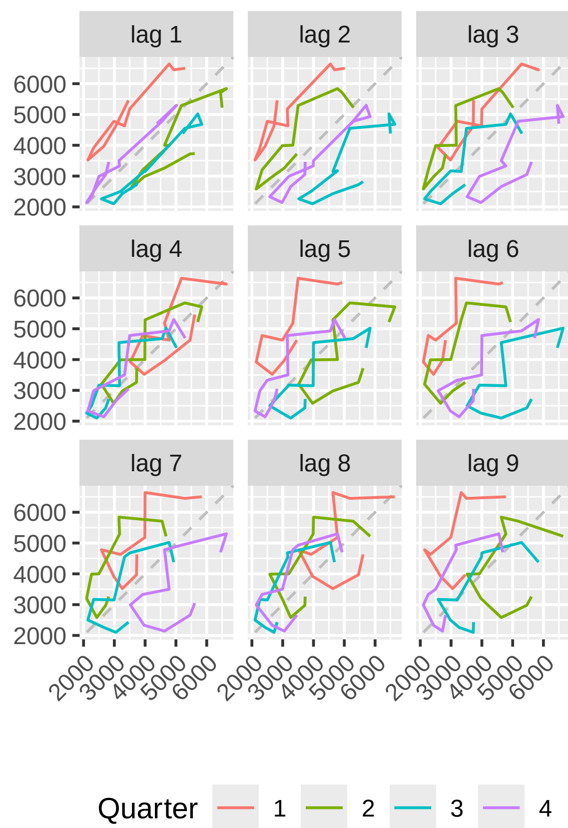

Figure 4: Lagged scatter plots of the quarterly unemployment in Canada in 1962-1973

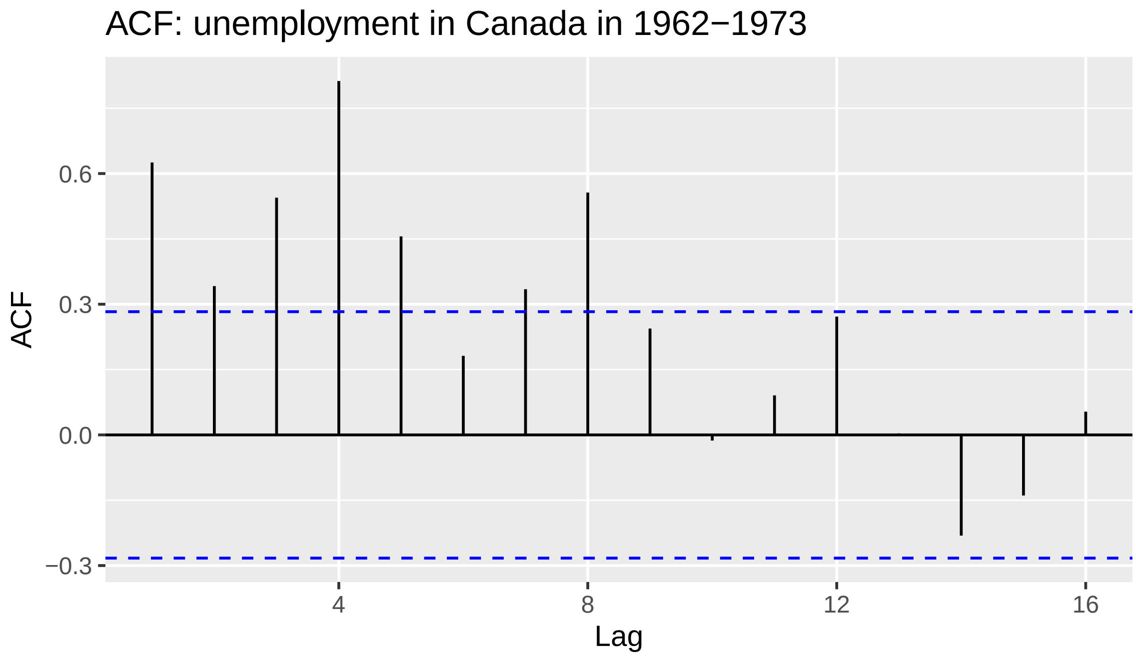

Figure 5: Autocorrelation Function (ACF) plot of the quarterly unemployment in Canada in 1962-1973

broader economic conditions within the limited time frame of the plot (spanning from 1962 to 1973) may be challenging. Extended data covering a more prolonged period would be necessary to reliably identify and confirm these broader economic trends and their impact on unemployment.

Based on the above, any forecasts of this series would need to capture the trend and seasonal patterns.

Detecting outliers in time series data in Figure 7 is critical as they can significantly impact analysis and forecasts (R code 8.7).

By generating boxplots for each quarter to detect outliers within each period, we conclude there are no outliers that could affect forecasting.

4.2 Regression modelling, analysis and forecasting

Considering the presence of changing trends and seasonality in the historical data, a regression model with trend and seasonal components as predictors seems appropriate. However,

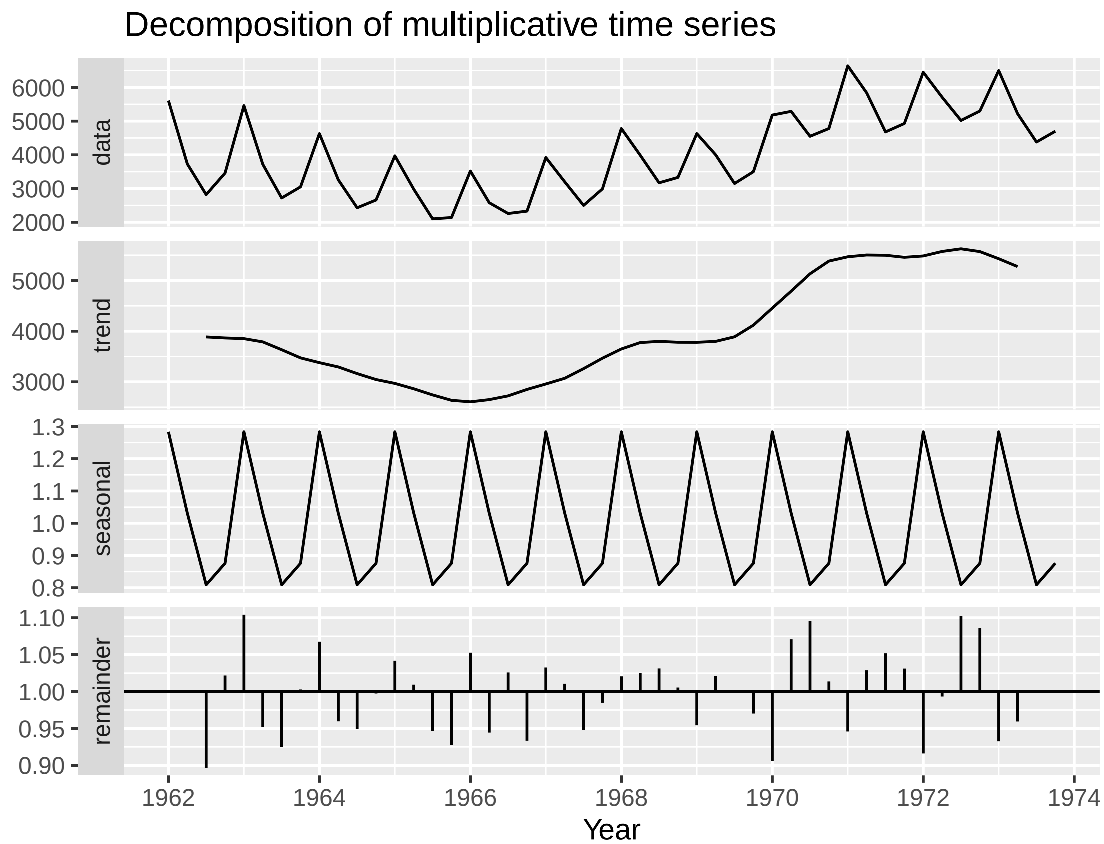

Figure 6: Decomposed quarterly unemployment in Canada in 1962-1973

Figure 7: Distribution of unemployment in Canada in 1962-1973 per quarter

to adjust the model to capture the parabolic shape of the time series, we add quadratic and cubic trend components to capture any curvature or parabolic shape in the training time series data. We will fit a polynomial regression model using the `tslm()` function in R, specifically designed for time series data (R code 8.8).

```
Table 3: Regression model summary


Call:
tslm(formula = training_data ~ trend + I(trend^2) + I(trend^3) +
    season)

Residuals:
    Min      1Q  Median      3Q     Max
-751.41 -261.72   48.11  231.77  732.82

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)  6.113e+03  2.407e+02  25.394  < 2e-16 ***
trend       -3.551e+02  4.045e+01  -8.779 5.80e-11 ***
I(trend^2)   1.651e+01  1.908e+00   8.653 8.57e-11 ***
I(trend^3)  -1.863e-01  2.561e-02  -7.274 6.78e-09 ***
season2     -9.863e+02  1.500e+02  -6.576 6.56e-08 ***
season3     -1.810e+03  1.505e+02 -12.026 5.00e-15 ***
season4     -1.544e+03  1.513e+02 -10.204 8.08e-13 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 366.9 on 41 degrees of freedom
Multiple R-squared:  0.9245,    Adjusted R-squared:  0.9135
F-statistic: 83.68 on 6 and 41 DF,  p-value: < 2.2e-16
```

The model demonstrates a good fit to the training data in Figure 8 (R code 8.9), explaining approximately 92.45% of the variance, and is statistically significant based on the F-statistic. The coefficients for the trend terms and seasonal components are statistically significant at conventional levels, indicating their significant effects on the response variable. Specifically, there is an average upward trend of 54.20 unemployed units per quarter. On average, the second quarter experienced unemployment at approximately 986.3 units lower than the first quarter, the third quarter was 1810 units lower, and the fourth quarter was 1544 units lower.

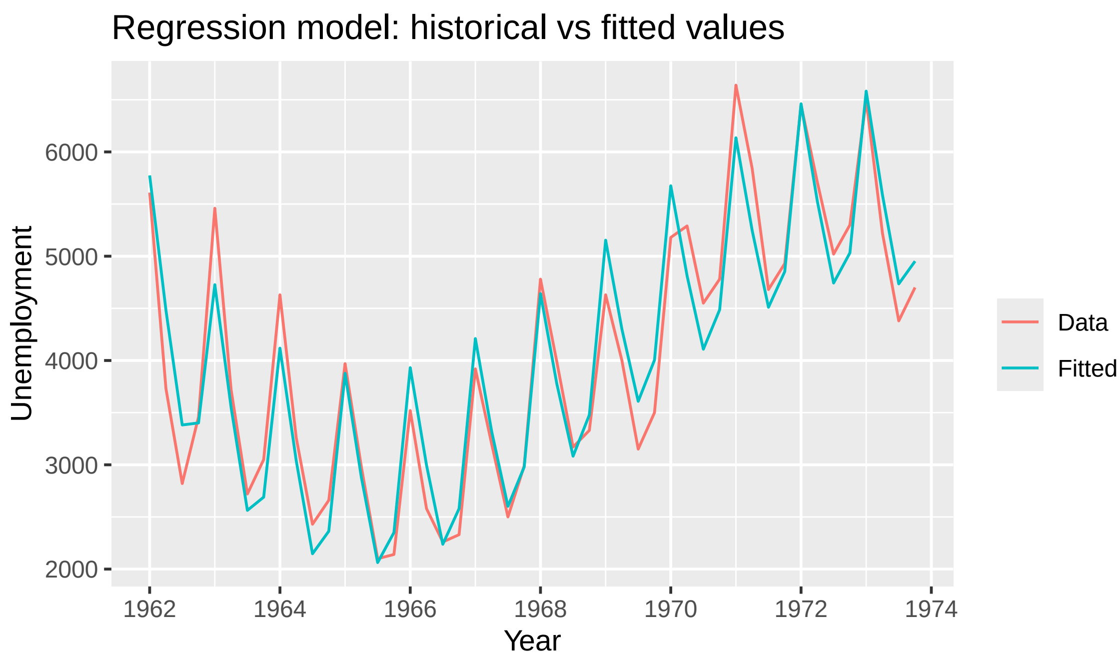

Figure 8: Regression model: quarterly unemployment in Canada in 1962-1973 vs. fitted values

The residual standard error is relatively low (366.9), suggesting that the model provides a satisfactory fit to the data. Based on the Shapiro-Wilk test (R code 8.10), there is no sufficient evidence to conclude that the residuals significantly depart from a normal distribution, indicating that the assumption of normality may be reasonable.

`Table 4: Shapiro-Wilk test of the regression model's training residuals`

```
    Shapiro-Wilk normality test
```

```
data:  regression_model$residuals
W = 0.98485, p-value = 0.7853
```

The residuals appear to be normally distributed, and there are no apparent patterns in the residual plots in Figure 9 (R code 8.11).

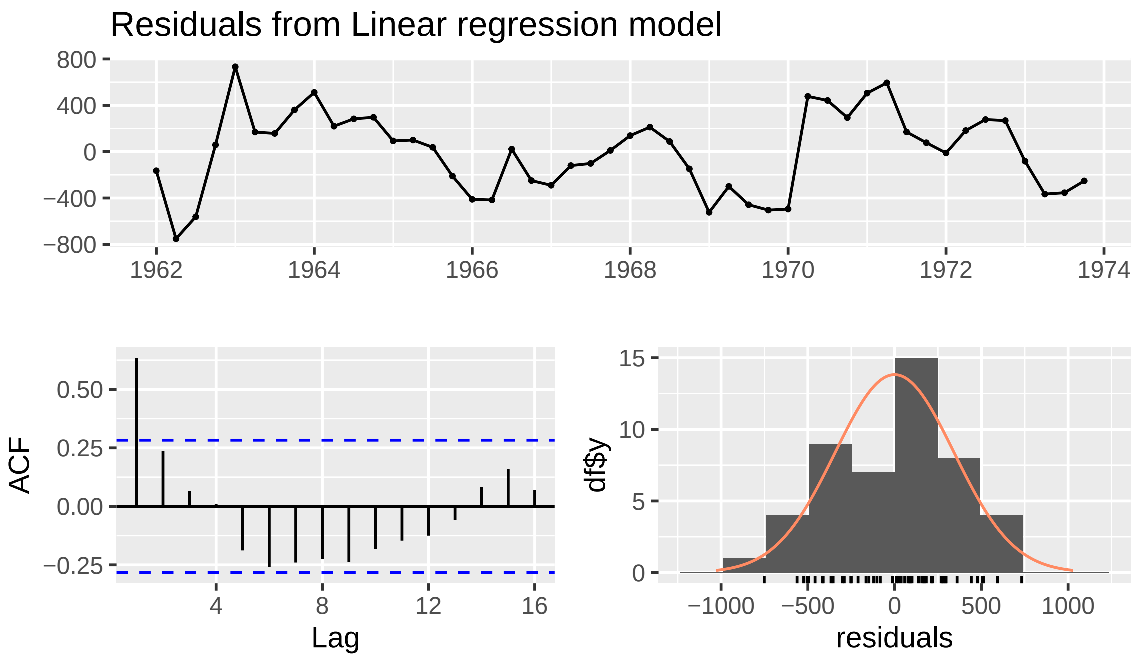

Figure 9: Training residuals from the regression model

```
	Breusch-Godfrey test for serial correlation of order up to 10

data:  Residuals from Linear regression model
LM test = 27.31, df = 10, p-value = 0.002326
```

However, the Breusch-Godfrey test, indicating evidence of serial correlation in the residuals from the linear regression model, and the residuals' Autocorrelation Function plot reveals significant autocorrelation at lag 1, suggesting a violation of the assumption of independence.

Subsequently, the Ljung-Box test confirms significant autocorrelation in the training residuals at lag 1, indicating that a time series model explicitly addressing autocorrelation, such as an ARIMA model, may offer a better fit (R code 8.12).

Table 5: Box-Ljung test of the regression model's training residuals

```
    Box-Ljung test

data:  regression_model$residuals
X-squared = 20.593, df = 1, p-value = 5.68e-06
```

When evaluating the regression model's forecasting performance on future data displayed as a dashed black line in Figure 10 (R code 8.13), we notice that it predicts unemployment reasonably well for the first four quarters, with the future data lying within the 80% confidence interval. However, future unemployment sharply increased during the last four quarters, contrary to the regression model's forecast, which exhibits a clear downward trend. This discrepancy suggests that the model may not capture specific patterns or information present in the data.

The Ljung-Box test suggests that there may be some remaining patterns or information in the out-of-sample residuals that the model has not captured, as the p-value (0.07898) is greater than the conventional significance level of 0.05 (R code 8.14).

```
    Ljung-Box test

data:  Residuals
Q* = 6.7876, df = 3, p-value = 0.07898

Model df: 0.   Total lags used: 3
```

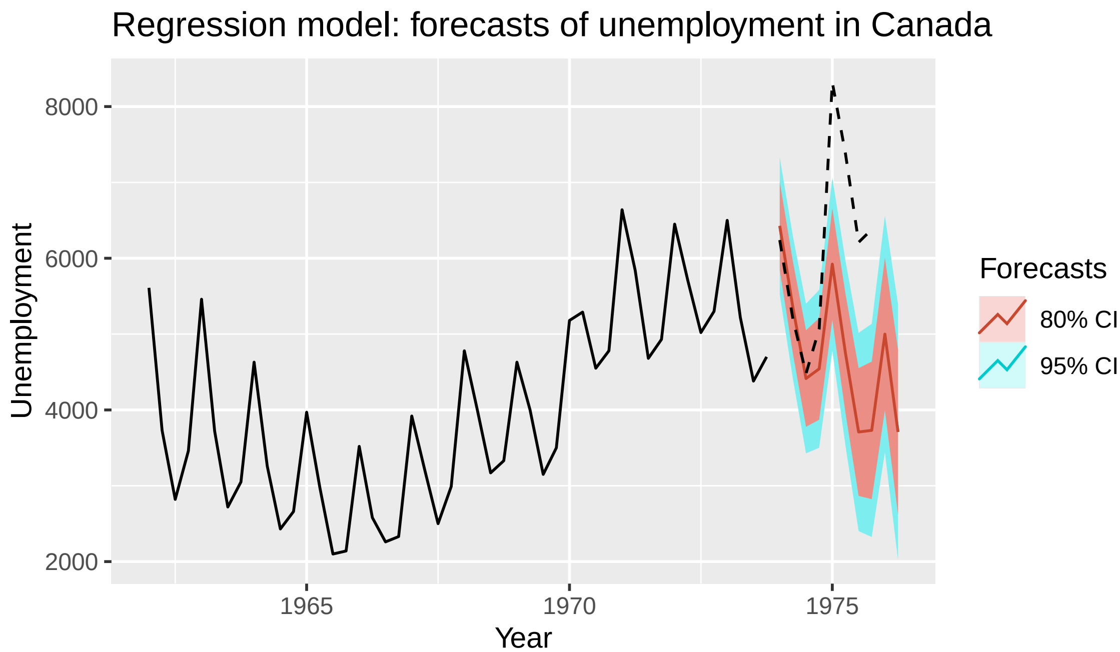

Figure 10: Regression model's eight-quarter forecast of unemployment in Canada

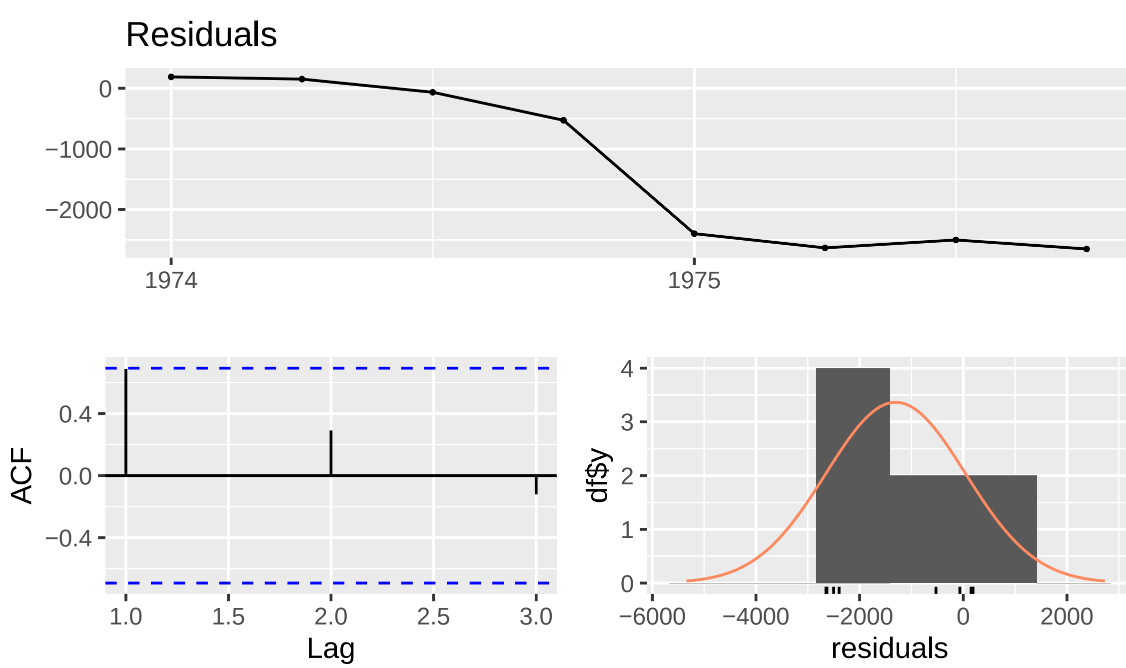

Figure 11: Regression model: out-of-sample residuals

We can use various evaluation metrics, such as MAE, RMSE, and MAPE, to evaluate the accuracy of the regression model's forecasts of future data (R code 8.15).

Table 6: Error measures evaluating the regression model's out-of-sample accuracy

Mean Absolute Error (MAE)	1388.74895
Root Mean Squared Error (RMSE)	1812.55196
Mean Absolute Percentage Error (MAPE)	20.50523
Forecast Bias	-1304.32674

An RMSE of 1812.552 indicates that, on average, the forecasted values deviate from the actual future values by approximately 1812.552 units. The MAPE suggests that, on average, the forecasts deviate from the actual future values by approximately 20.50523%. The bias indicates that, on average, the forecasts tend to underestimate the actual values by approximately 1304.327 units.

Overall, the forecasting performance of this model seems to have moderate accuracy. The MAE, RMSE, and MAPE values suggest that the forecasts have a reasonable level of accuracy, although there is room for improvement. Additionally, the negative bias indicates a tendency for the forecasts to be consistently lower than the actual values.

Notably, the significant jump in unemployment observed in 1975, the highest value throughout the observation period, indicates an extraordinary event that the model could not consider. This highlights the challenge of forecasting, which assumes that future patterns and behaviours will resemble those observed in the past.

4.3 Exponential smoothing modelling, analysis and forecasting

To manually fit a model from the exponential smoothing family, tailored for time series data exhibiting trend and seasonality, the Holt-Winters method is a suitable choice. This method extends simple exponential smoothing to accommodate data with both trend and seasonality. We will fit the Holt-Winters model incorporating multiplicative error, additive trend with damping, and multiplicative seasonality components (ETS(M,Ad,M)) (R code 8.16).

```
Table 7: Exponential Smoothing model with the Holt-Winters method summary

ETS(M,Ad,M)


Call:
 ets(y = training_data, model = "MAM", damped = TRUE)


  Smoothing parameters:
    alpha = 0.4065
    beta  = 0.4065
    gamma = 0.5796
    phi   = 0.8758


  Initial states:
    l = 4134.9175
    b = -5.4187
    s = 0.881 0.7053 0.9446 1.4691


  sigma:  0.0855


     AIC     AICc      BIC
752.0501 757.9960 770.7621


Training set error measures:
                    ME     RMSE      MAE        MPE     MAPE      MASE
Training set -28.89258 321.5432 244.6389 -0.1225624 5.976051 0.5334049
                  ACF1
```

```
Training set 0.3023249
```

A sigma value of 0.0855 suggests that the model captures a significant portion of the variability in the training data. Additionally, the relatively low values of AIC, AICc, and BIC are positive indicators of model fit.

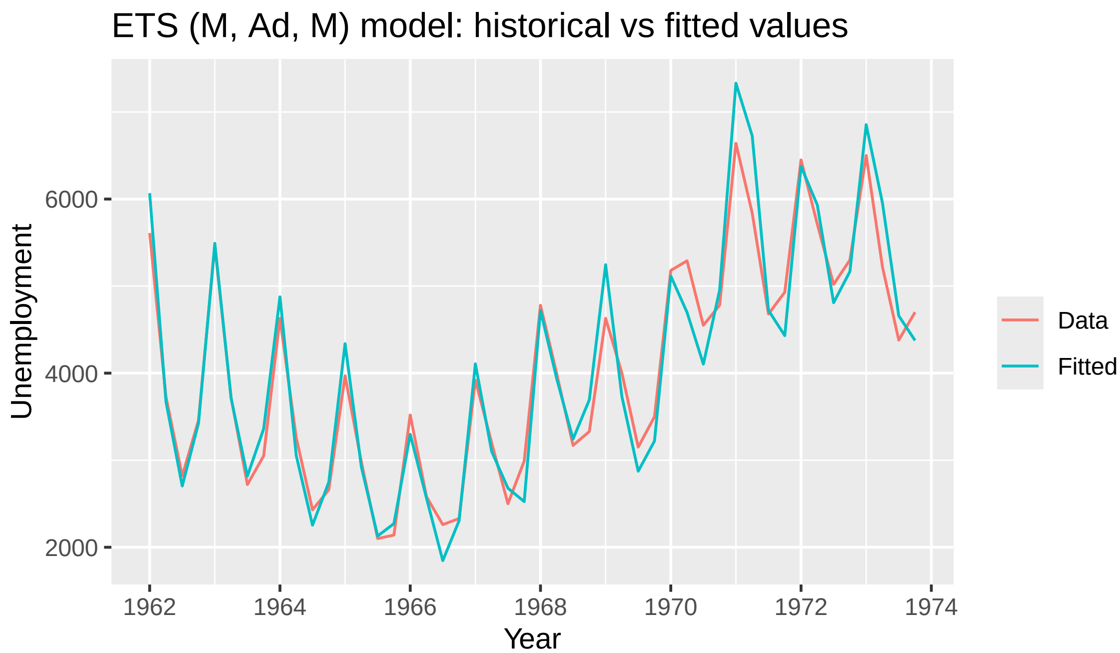

Figure 12: Exponential smoothing (ETS (M, Ad, M)) model: quarterly unemployment in Canada in 1962-1973 vs. fitted values

Upon examination of residuals (R code 8.17), they appear to be normally distributed without any discernible patterns.

```
    Ljung-Box test

data:  Residuals from ETS(M,Ad,M)
Q* = 14.359, df = 8, p-value = 0.07287

Model df: 0.   Total lags used: 8
```

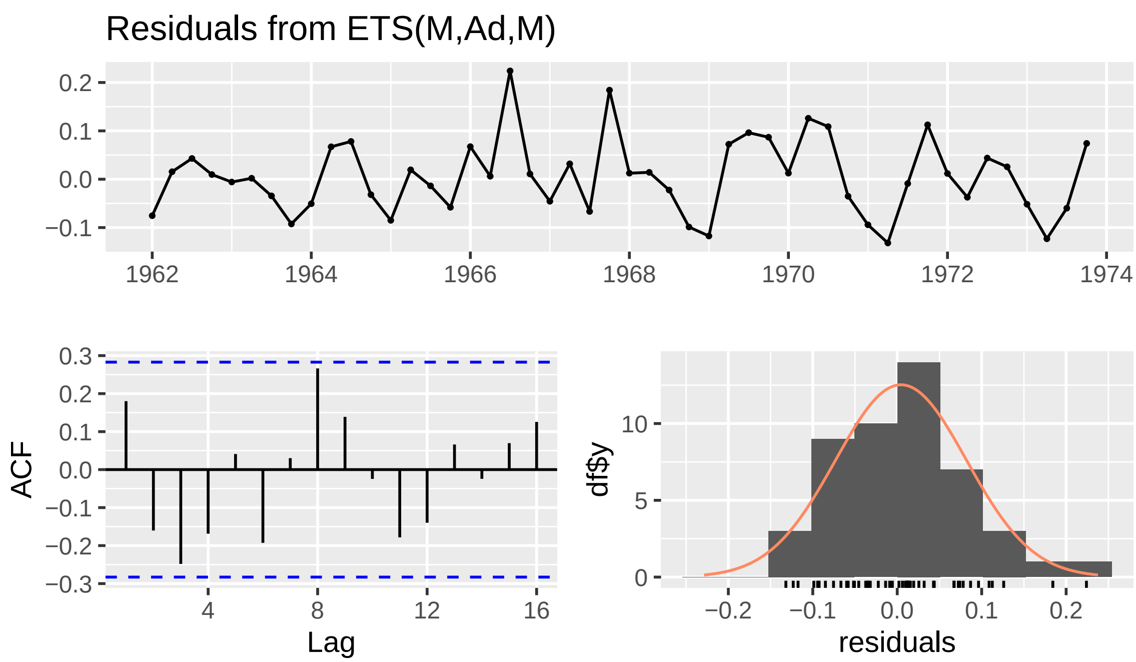

Figure 13: Exponential smoothing (ETS (M, Ad, M)) model: training residuals

It is supported by the Shapiro-Wilk test results, which do not provide sufficient evidence to reject the assumption of normality (R code 8.18).

```
Table 8: Shapiro-Wilk test of the exponential smoothing model's training residuals



    Shapiro-Wilk normality test


data:  hw_model$residuals
W = 0.97488, p-value = 0.3875
```

However, further evaluation of the model on future data is warranted to provide a comprehensive assessment.

When evaluating the forecasting accuracy of the exponential smoothing model with the Holt-Winters method against future data in Figure 14 (R code 8.19), we observe that while the future data aligns with the 95% confidence interval for the first four quarters, it surpasses the forecasted range thereafter.

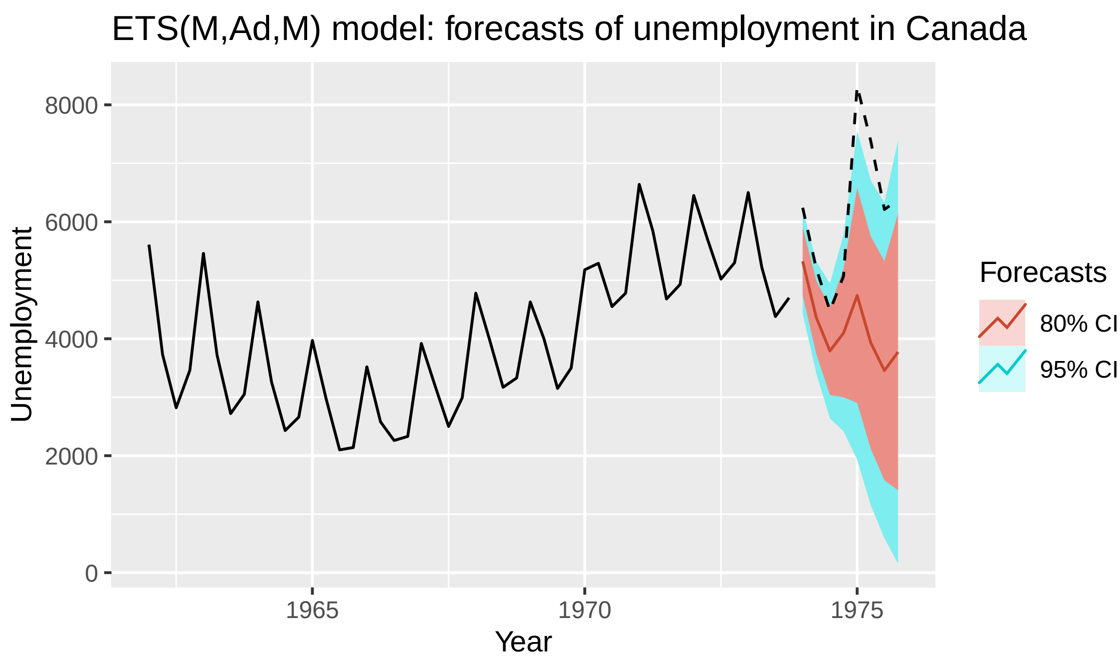

Figure 14: Exponential smoothing (ETS (M, Ad, M)) model's eight-quarter forecast of unemployment in Canada

This discrepancy makes it challenging to directly assess the model's forecasting performance solely based on this plot. Therefore, we conduct residual analysis in Figure 15 to obtain a more objective evaluation and examine various evaluation metrics such as MAE, RMSE, and MAPE (R code 8.20).

```
    Ljung-Box test

data:  Residuals
Q* = 4.8876, df = 3, p-value = 0.1802

Model df: 0.   Total lags used: 3
```

The Ljung-Box Test Statistic's p-value (0.1802) is greater than the commonly used significance level of 0.05, suggesting no significant autocorrelation in the residuals at the specified lags.

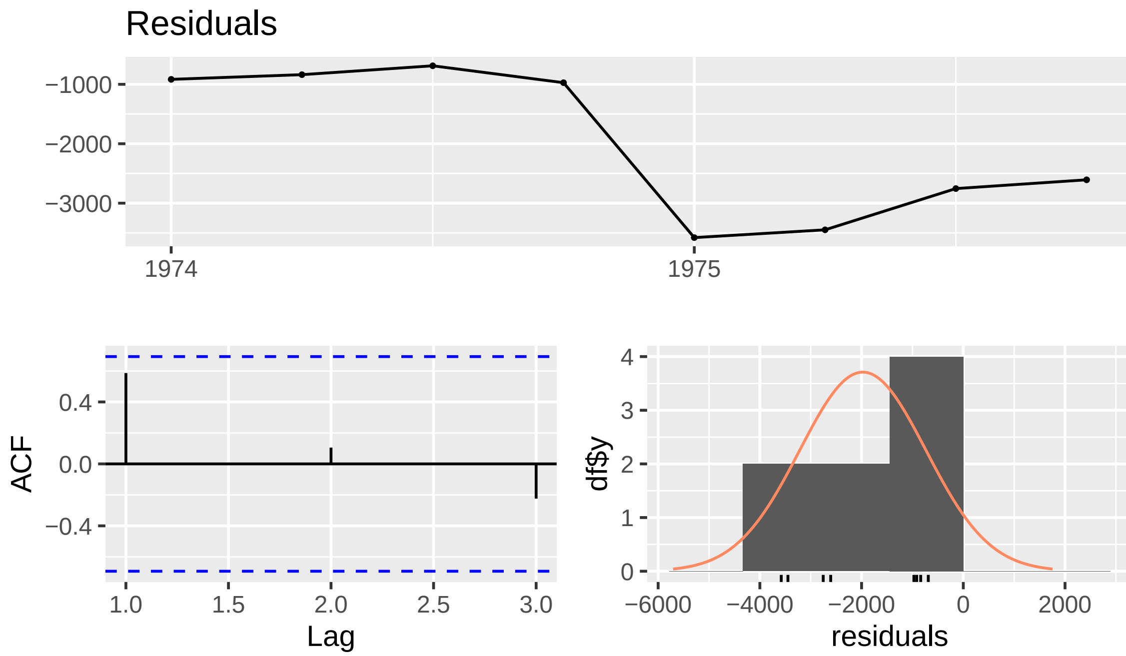

Figure 15: Exponential smoothing (ETS (M, Ad, M)) model: out-of-sample residuals

However, the model exhibits poor performance compared to the future data (R code 8.21).

`Table 9: Error measures evaluating ETS(M,Ad,M) model's out-of-sample accuracy`

Mean Absolute Error (MAE)	1975.5170
Root Mean Squared Error (RMSE)	2292.6355
Mean Absolute Percentage Error (MAPE)	30.0379
Forecast Bias	-1975.5170

High MAE and RMSE values indicate significant deviations from actual values on average, while a MAPE of 30.0379% suggests considerable discrepancies relative to actual values. A lower MAPE is desired for more accurate forecasts. Furthermore, the negative bias indicates a systematic underestimation of actual values.

In conclusion, the model's performance is subpar, characterised by high errors, substantial deviations from actual future values, and systematic bias. Further refinement or alternative modelling approaches may be necessary to enhance forecasting accuracy.

4.4 ARIMA modelling, analysis and forecasting

As established earlier in this report, the historical time series data exhibits trend and seasonality components, rendering it non-stationary. This is confirmed by the Autocorrelation Function (ACF) plot in Figure 16 (R code 8.22), which displays multiple spikes outside the confidence intervals, with a notably strong and significantly positive first lag.

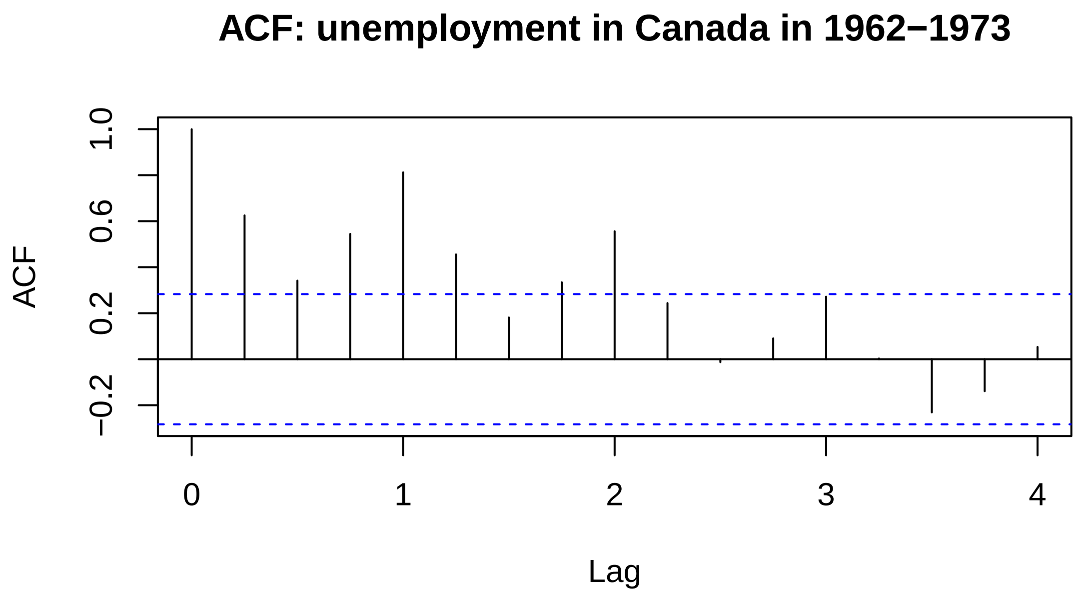

Figure 16: Autocorrelation Function (ACF) plot of the quarterly unemployment in Canada in 1962-1973

To address non-stationarity, differencing can stabilise the time series' mean and eliminate trends and seasonality. Augmented Dickey-Fuller (ADF) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests are conducted to determine the necessity of differencing objectively (R code 8.23).

```
Table 10: Augmented Dickey-Fuller (ADF) test of the training data



    Augmented Dickey-Fuller Test
```

```
data:  training_data
Dickey-Fuller = -1.9397, Lag order = 3, p-value = 0.5982
alternative hypothesis: stationary
```

The ADF test yields a high p-value (0.5982), failing to reject the null hypothesis of non-stationarity, while the KPSS test, with a p-value of 0.01, rejects the null hypothesis of stationarity around a level:

```
Table 11: Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test of the training data


    KPSS Test for Level Stationarity


data:  training_data
KPSS Level = 0.80281, Truncation lag parameter = 3, p-value = 0.01
```

As the next step, we can use `ndiffs()` and `nsdiffs()` functions to determine the appropriate number of first and seasonal differencing for the training data (R code 8.24):

```
Number of first differecings:  1

Number of seasonal differecings:  1
```

A Box-Cox transformation will not be performed due to the absence of evidence indicating variance changes.

Subsequently, the first and seasonal differencings are applied to the historical data, followed by an examination of the ACF/PACF plots in Figure 17 (R code 8.25).

The absence of significant spikes in the ACF plot beyond lag 0 suggests no need for autoregressive (AR) terms, while the significant spike at lag 1 in the PACF plot suggests a potential need for a Moving Average (MA) component.

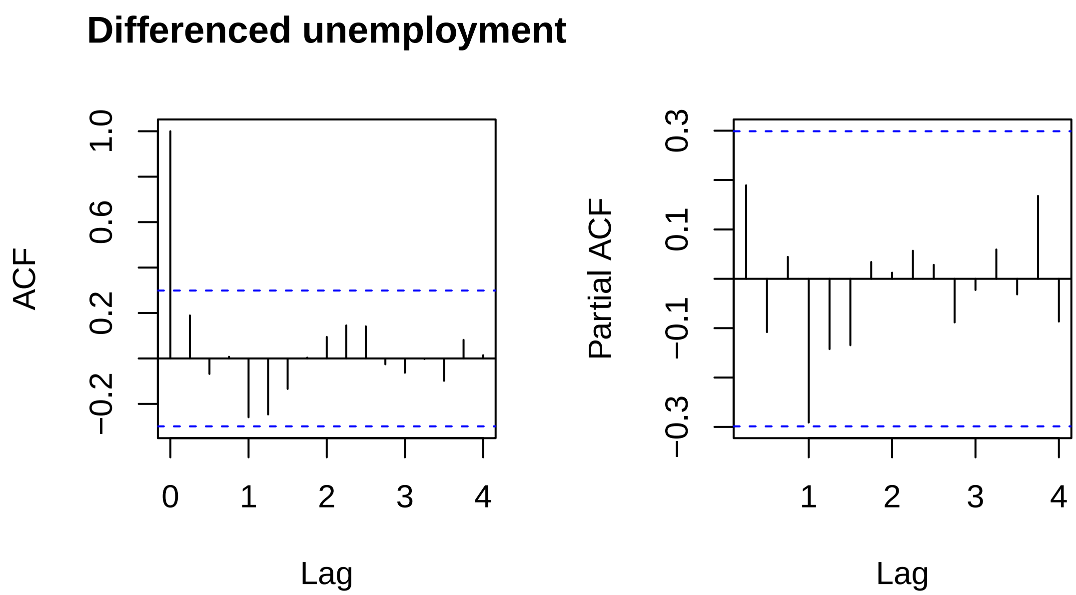

Figure 17: Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) plots of the quarterly unemployment in Canada in 1962-1973

The efficacy of differencing is further confirmed by plotting the differenced historical data in Figure 18 together with performing the ADF test in Table 12, indicating stationarity of the differenced series, while the KPSS test in Table 13 fails to reject the null hypothesis of stationarity (R codes 8.26).

Table 12: Augmented Dickey-Fuller (ADF) test of the differenced data

```
    Augmented Dickey-Fuller Test

data:  training_diff
Dickey-Fuller = -4.2479, Lag order = 3, p-value = 0.01
alternative hypothesis: stationary
```

Table 13: Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test of the differenced data

```
    KPSS Test for Level Stationarity


data:  training_diff
KPSS Level = 0.11986, Truncation lag parameter = 3, p-value = 0.1
```

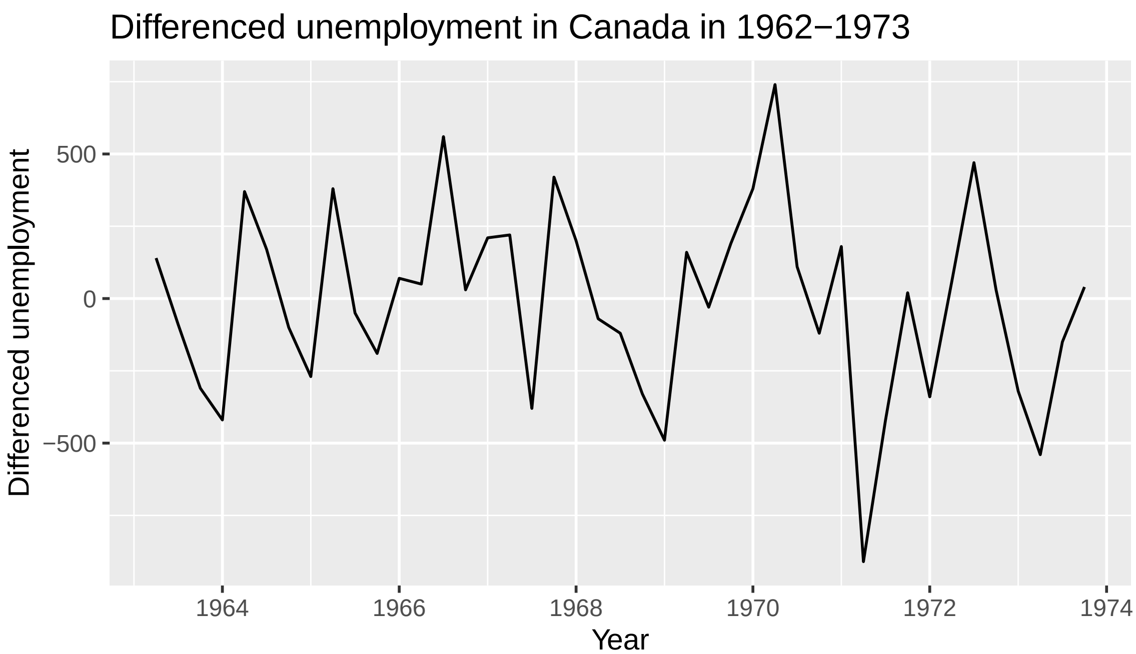

Figure 18: Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) plots of the differenced training data

With stationarity achieved, modeling using ARIMA (AutoRegressive Integrated Moving Average) methods becomes feasible. Based on observations, an initial ARIMA model of ARIMA(0,1,0)(1,1,0)[4] is proposed, accounting for differencing and seasonality (R code 8.27).

```
Table 14: ARIMA(0,1,0)(1,1,0)[4] model summary


Series: training_data
ARIMA(0,1,0)(1,1,0)[4]


Coefficients:
```

```
         sar1
      -0.2806
s.e.   0.1504

sigma^2 = 97474:  log likelihood = -307.65
AIC=619.3   AICc=619.6   BIC=622.82

Training set error measures:
                    ME     RMSE      MAE       MPE     MAPE      MASE      ACF1
Training set -5.924679 292.0447 219.2004 0.2442629 5.699038 0.4779394 0.1445496
```

These statistical measures provide a way to compare the goodness of fit among different models. In this case, the log-likelihood is -307.65, and the AIC, AICc, and BIC are 619.3, 619.6, and 622.82, respectively. Lower values of AIC, AICc, and BIC indicate a better fit, suggesting that the model is relatively good compared to alternative models.

The seasonal autoregressive term (sar1) coefficient is -0.2806, indicating a negative relationship between the observations and their seasonal lagged values. This coefficient's standard error (s.e.) is 0.1504, suggesting a relatively precise estimate.

The MPE (Mean Percentage Error) is 0.2442629%, which measures the average relative error. It's close to 0, indicating that, on average, the model's forecasts are accurate.

Residual analysis in Figure 20 (R code 8.28) reveals normally distributed residuals with no significant autocorrelation, further affirming the adequacy of the ARIMA model.

```
    Ljung-Box test

data:  Residuals from ARIMA(0,1,0)(1,1,0)[4]
Q* = 5.5894, df = 7, p-value = 0.5884

Model df: 1.   Total lags used: 8
```

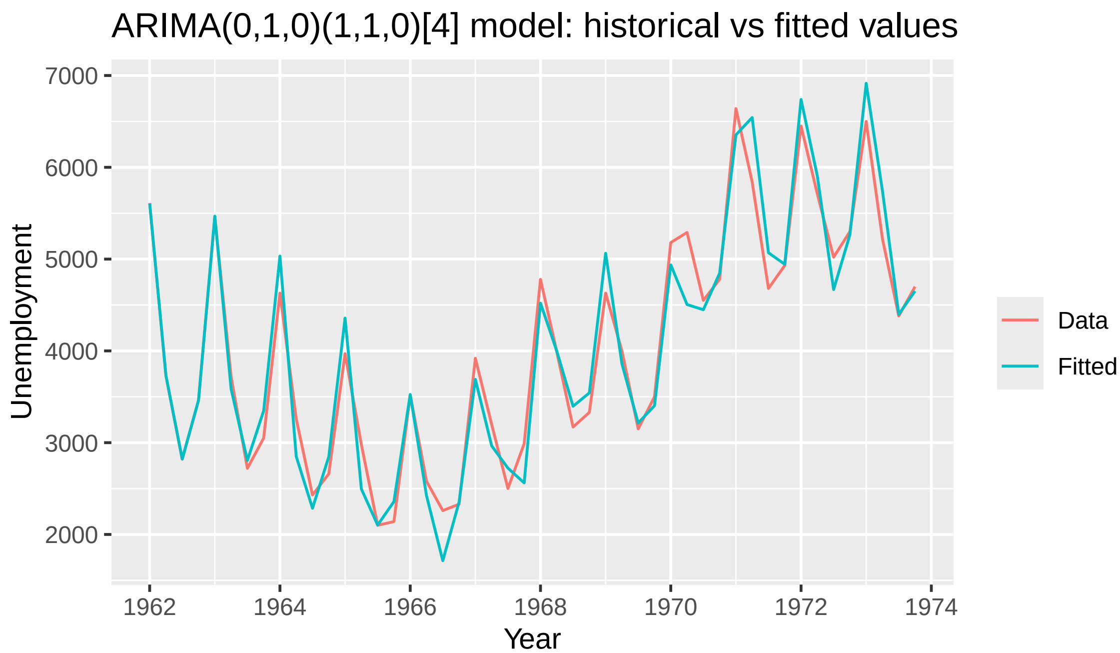

Figure 19: ARIMA(0,1,0)(1,1,0)[4] model: quarterly unemployment in Canada in 1962-1973 vs fitted values

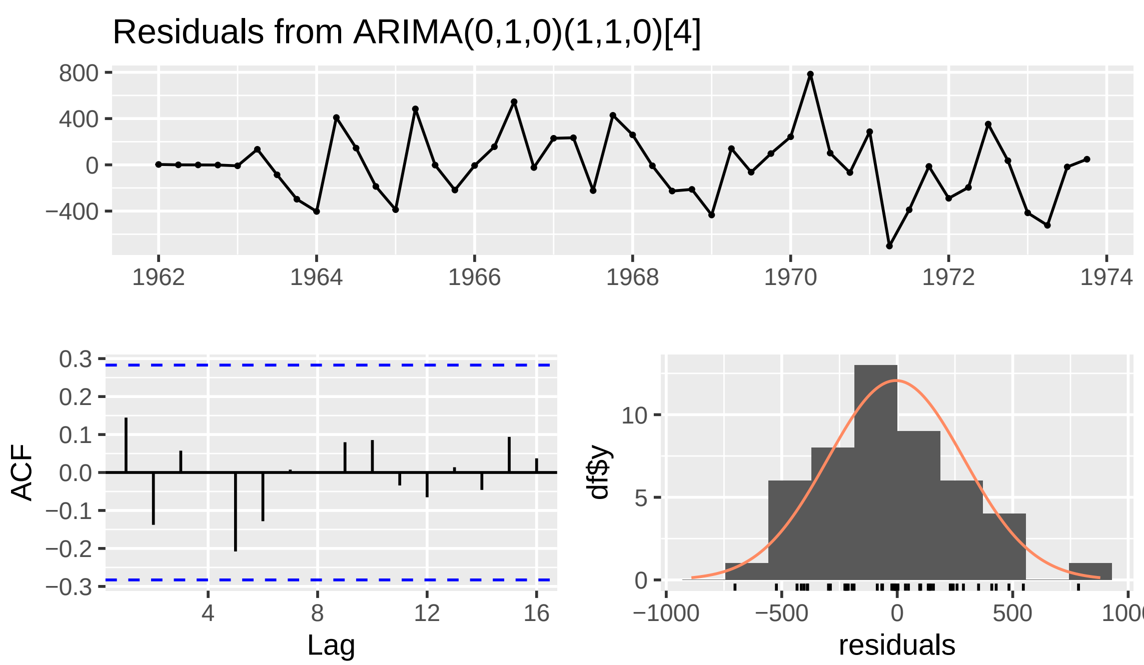

Figure 20: ARIMA(0,1,0)(1,1,0)[4] model: training residuals

The Ljung-Box test result, with a p-value of 0.5884, indicates that the model adequately captures the temporal dependence structure present in the historical data.

The Shapiro-Wilk test (R code 8.29), which assesses the normality of the residuals from the ARIMA model, does not provide sufficient evidence to reject the null hypothesis of normality. This suggests that the residuals from the ARIMA model are approximately normally distributed.

Table 15: Shapiro-Wilk test of the ARIMA model's training residuals

```
    Shapiro-Wilk normality test

data:  arima_model$residuals
W = 0.98638, p-value = 0.8451
```

Upon forecasting performance evaluation against future data, the ARIMA model exhibits reasonably low errors and bias, indicating satisfactory performance, albeit challenges in predicting extraordinary spikes in future data in Figure 21 (R code 8.30).

The Ljung-Box Test Statistic's p-value (0.09731) rejects the null hypothesis of no autocorrelation in the residuals, suggesting no significant autocorrelation present in the residuals at the specified lags (R code 8.31).

```
    Ljung-Box test

data:  Residuals
Q* = 6.3136, df = 3, p-value = 0.09731

Model df: 0.   Total lags used: 3
```

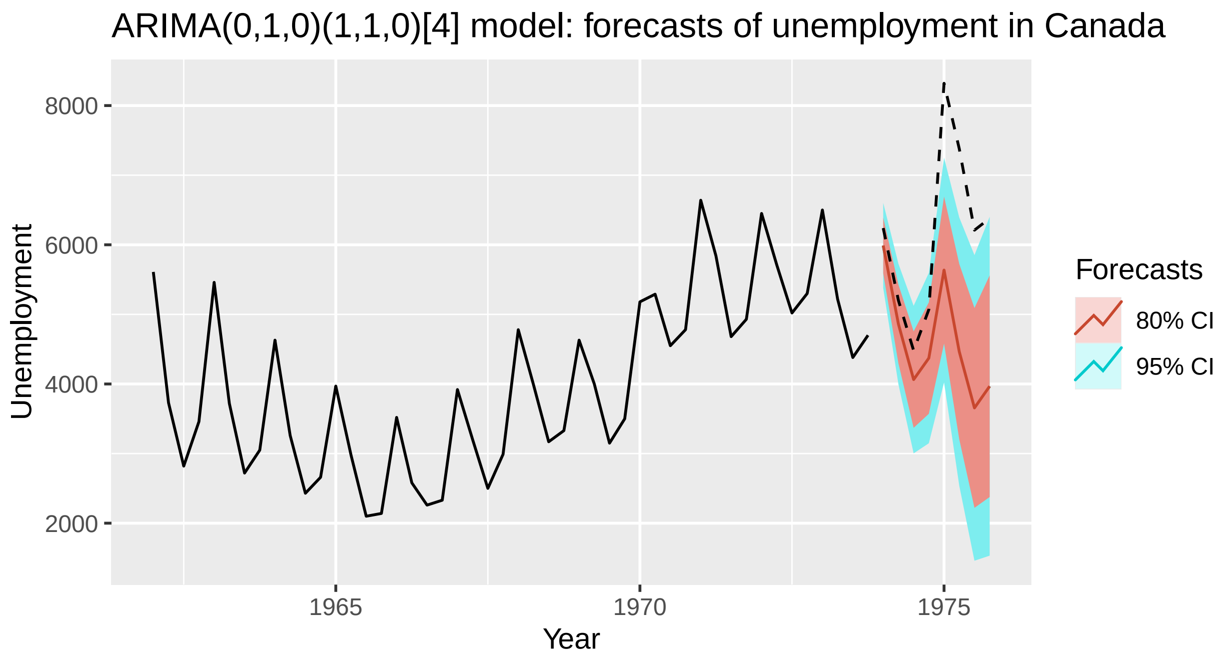

Figure 21: ARIMA(0,1,0)(1,1,0)[4] model's eight-quarter forecast of unemployment in Canada

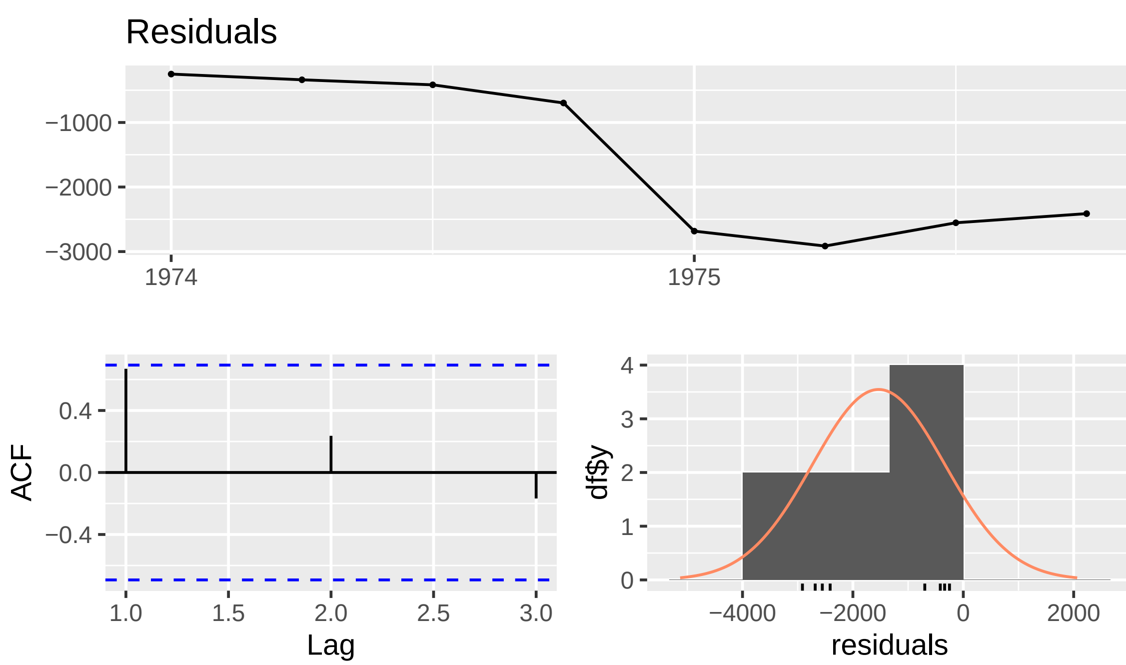

Figure 22: ARIMA(0,1,0)(1,1,0)[4] model: out-of-sample residuals

The metrics from Table 16 suggest that the model's forecasts have relatively low errors and bias, indicating reasonably good performance, considering the future data had extraordinary spikes (R code 8.32).

Table 16: Error measures evaluating the ARIMA model's out-of-sample accuracy

Mean Absolute Error (MAE)	1533.36923
Root Mean Squared Error (RMSE)	1899.72019
Mean Absolute Percentage Error (MAPE)	23.03253
Forecast Bias	-1533.36923

Comparative analysis of Mean Absolute Percentage Errors (MAPEs) among the three forecasting models helps identify the most suitable model (R code 8.33). It is a reasonable approach, especially if the models have different structures or complexities, such as the regression model, which includes polynomial terms. MAPE is a relative error metric that accounts for the magnitude of the forecasted values, which can be helpful when comparing models with different scales:

Table 17: Error measures evaluating out-of-sample accuracy of the three models

Model	MAE	RMSE	MAPE	Bias
ARIMA	1533.369	1899.720	23.03253	-1533.369
Exponential Smoothing	1975.517	2292.636	30.03790	-1975.517
Regression	1388.749	1812.552	20.50523	-1304.327

```
Best Model based on MAPE: Regression
```

However, it's crucial to acknowledge that the three forecasting models struggled to forecast unemployment in Canada after 1975 due to the complex and multifaceted nature of the economic conditions during that period. The global economic recession, triggered by the oil crisis of 1973-1974, resulted in stagnant growth and rising unemployment rates worldwide (Bank of Canada, 1999). Industrial restructuring, trade disruptions, and technological advancements further exacerbated job losses across various sectors. Government policies aimed at curbing inflation may have inadvertently worsened unemployment levels. The interplay of these factors created a highly volatile and uncertain economic environment, making it challenging for forecasting models to capture and predict unemployment dynamics during that time accurately.

5 Batch Forecasting

5.1 Exploratory analysis

In this section of the report, we undertake batch forecasting on a subset of quarterly time series data from the M3 competition, specifically focusing on IDs 1001 to 1100. It comprises historical data utilised for fitting automatic forecasting models and future data used to evaluate the forecasting performance of the fitted models. Each time series represents a historical record of a specific variable, such as sales numbers, stock prices, or production levels. For instance, the time series with ID 1001 tracks the volume indices of exports (both goods and services) from Japan (R code 8.34).

```
Table 18: M3 competition series ID 1001

Series: Q356
Type of series: MACRO
Period of series: QUARTERLY
Series description: OECD ECONOMIC OUTLOOK - JAPAN Export(Goods-Services)- Volume Indeces

HISTORICAL data
       Qtr1   Qtr2   Qtr3   Qtr4
1980 3311.5 3368.0 3363.0 3504.0
```

```
1981 3609.5 3848.0 4018.5 3980.5
1982 4016.0 4009.0 4053.0 4002.5
1983 3928.0 3983.0 4140.5 4305.0
1984 4481.5 4630.5 4739.0 4934.0
1985 4923.5 5135.5 4987.0 4951.5
1986 4692.0 4793.5 4681.0 4774.5
1987 4791.5 4839.0 5047.5 5140.0
1988 5198.0 5257.0 5713.0 5772.5
1989 5965.0 6168.0 6473.0 6638.0
1990 6928.5 7034.0 6874.5 7055.0

FUTURE data
       Qtr1   Qtr2   Qtr3   Qtr4
1991 7246.5 7146.0 7357.0 7469.0
1992 7507.5 7380.0 7449.5 7587.5
```

The primary objective of this section of the report is to select, automatically fit, and evaluate three distinct statistical models (ARIMA, ETS, and TBATS) for forecasting quarterly time series of IDs from 1001 to 1100 from the M3 competition data set.

5.2 Error measures selection

Following the generation of forecasts for the next eight quarters, we will assess their accuracy using two appropriate error measures:

Mean Absolute Percentage Error (MAPE) measures the percentage difference between the actual future and forecasted values, offering a relative measure of forecast accuracy. MAPE represents the average percentage error of the forecast relative to the future data. Its simplicity makes it easy to understand and communicate to stakeholders.

Symmetric Mean Absolute Percentage Error (sMAPE) measures the percentage difference between future and forecasted values in a symmetric manner, meaning it does not favour overestimation or underestimation. It calculates the absolute percentage error for each observation and then averages these errors across all observations. sMAPE is scale-independent, allowing for comparison of forecast accuracy across different data sets and variables. Its symmetry treats positive and negative errors equally, which can be advantageous in various forecasting scenarios.

While MAPE offers simplicity and straightforwardness, sMAPE provides additional robustness and symmetry, rendering it suitable for a broader range of forecasting scenarios. Both measures are valuable for comparing forecast accuracy across different time series with varying scales, aiding in comprehensive evaluation and decision-making processes.

5.3 Benchmarking

In addition to evaluating each model's accuracy using MAPE and sMAPE, we will compare their performance against two benchmark methods:

Theta model considers both the level and trend of the time series data. Theta forecasting provides a straightforward baseline for comparison, capturing basic trends in the data without incorporating more complex patterns. One advantage of Theta forecasting is its simplicity and ease of implementation, making it suitable for quick assessments of forecasting performance. According to Makridakis and Hibon (2000), despite its apparent simplicity and lack of reliance on robust statistical foundations, the Theta method exhibits remarkable accuracy across various series types, forecasting timeframes, and evaluation metrics. However, it may overlook more subtle patterns or seasonality in the data, limiting its accuracy compared to more sophisticated models.

Damped Exponential Smoothing is a variation of exponential smoothing that diminishes the influence of past observations as the forecast horizon extends. This method accounts for the decreasing relevance of historical data as time progresses, offering a more nuanced approach than the theta model's simplicity. Damped exponential smoothing is advantageous as it adapts to changing data patterns over time, providing smoother and often more accurate forecasts. However, it may struggle with abrupt changes or outliers in the data, potentially leading to inaccuracies in forecasting during periods of volatility.

By comparing the performance of the models against these benchmark methods, we can gain insights into their relative effectiveness and assess their ability to outperform basic forecasting approaches. This comparative analysis will aid in identifying the strengths and weaknesses of each model, guiding decision-making processes and informing future forecasting strategies.

5.4 Automatic ARIMA model

The `auto.arima()` function in R automatically selects the optimal ARIMA parameters for each time series data (IDs 1001 to 1100) from the M3 competition data set based on the corrected Akaike Information Criterion (AICc) (R code 8.35)[1]. However, it may not effectively capture complex seasonal patterns or structural changes in the data, leading to suboptimal forecasts in certain cases. The automatic ARIMA model may also struggle with noisy or irregular data, requiring additional preprocessing or model refinement to improve forecasting accuracy.

After computing the average Mean Absolute Percentage Error (MAPE) and Symmetric Mean Absolute Percentage Error (sMAPE) for the ARIMA models, we compare its performance with the Theta and Damped Exponential Smoothing models, which serve as benchmarks (R code 8.36). Individual error values are calculated for each method across multiple time series.

```
Table 19: Error measures evaluating automatic ARIMA model's out-of-sample accuracy
```

Model	MAPE	sMAPE
ARIMA	5.683726	5.370717
Theta	5.541910	5.291370
Damped Exponential Smoothing	4.672529	4.539832

```
Best model based on MAPE: Damped Exponential Smoothing
```

[1] Appendix 8.35 contains a comprehensive list of automatically fitted ARIMA models for each series and their respective forecasted values.

```
Best model based on sMAPE: Damped Exponential Smoothing
```

The ARIMA model's forecasts have an absolute percentage error of approximately 5.68%, with a symmetric perspective suggesting a slightly lower error of around 5.37%.

The Theta forecast model's predictions demonstrate a lower absolute percentage error than the ARIMA model while showing a slightly lower error from a symmetric perspective.

Conversely, the Damped Exponential Smoothing model displays the lowest average MAPE of around 4.67% and the lowest average sMAPE of about 4.54%. These results indicate that the Damped Exponential Smoothing model offers the most accurate forecasts among the three methods, with both MAPE and sMAPE indicating lower error rates than the ARIMA and Theta forecast models.

5.5 Automatic Error-Trend-Seasonality (ETS) model

The `ets()` function in R automatically selects the optimal ETS (Error, Trend, Seasonality) model based on each series' data characteristics, such as the presence of trend and seasonality. The fitted ETS model contains information about the estimated parameters, including the level, trend, and seasonal components for each series and any additional settings or options specified during the fitting process (R code 8.37)[2]. However, it may be computationally intensive for large-scale forecasting tasks and could produce suboptimal results if the underlying data contains irregular patterns or outliers.

Similarly to the auto ARIMA model, we calculate the average Mean Absolute Percentage Error (MAPE) and Symmetric Mean Absolute Percentage Error (sMAPE) for the ETS forecasting models and compare them with the metrics for Theta and Damped Exponential Smoothing models as benchmarks (R code 8.38).

`Table 20: Error measures evaluating automatic ETS model's out-of-sample accuracy`

[2] Appendix 8.37 contains a comprehensive list of automatically fitted ETS models for each series and their respective forecasted values.

```
                      Model     MAPE    sMAPE
                        ETS 5.140505 4.936170
                      Theta 5.541910 5.291370
Damped Exponential Smoothing 4.672529 4.539832

Best model based on MAPE: Damped Exponential Smoothing

Best model based on sMAPE: Damped Exponential Smoothing
```

The ETS model exhibits a MAPE of 5.14%, indicating that, on average, its forecasts have a percentage error of approximately 5.14% compared to the future values. Additionally, it has an sMAPE of 4.94%, suggesting that, on average, its forecasts have a symmetric percentage error of approximately 4.94% compared to the future data.

Although the Damped Exponential Smoothing model slightly outperforms the ETS model, the latter still exhibits superior accuracy compared to the Theta model. Therefore, the ETS model remains a reliable choice for forecasting, especially considering its competitive performance. Factors such as computational simplicity or model interpretability may further support selecting the ETS model for forecasting tasks.

5.6 Automatic Trigonometric Seasonal Box-Cox Transformation, ARMA errors, Trend, and Seasonal components (TBATS) model

The TBATS model is renowned for its capability to handle multiple seasonalities, trends, and complex patterns in time series data (Brozyna, Mentel and Szetela, 2016). It is particularly useful for data sets with intricate seasonal patterns and irregular trends. It is preferred for automatic forecasting tasks where data may exhibit multiple seasonalities and nonlinear patterns. However, it may suffer from computational intensity, especially with large data sets, and might require tuning parameters for optimal performance in certain cases.

TBATS decomposes the time series into components, including multiple seasonalities and trends, utilising trigonometric functions and Box-Cox transformations. Subsequently, it fits an ARMA model to the residuals to capture any remaining temporal dependencies, providing forecasts based on the estimated components and model parameters (R code 8.39)[3].

Similar to the auto ARIMA and ETS models, we compute the average Mean Absolute Percentage Error (MAPE) and Symmetric Mean Absolute Percentage Error (sMAPE) for the TBATS forecasting models and compare them with the metrics for Theta and Damped Exponential Smoothing models as benchmarks (R code 8.40).

```
Table 21: Error measures evaluating automatic TBATS model's out-of-sample accuracy

                        Model     MAPE    sMAPE
                        TBATS 6.156728 5.829611
                        Theta 5.541910 5.291370
 Damped Exponential Smoothing 4.672529 4.539832

Best model based on MAPE: Damped Exponential Smoothing

Best model based on sMAPE: Damped Exponential Smoothing
```

The TBATS model shows an average MAPE of about 6.16% and an sMAPE of around 5.83%. However, the Damped Exponential Smoothing and Theta models outperform it, with average MAPEs of 4.67% and 5.54% and sMAPEs of 4.54% and 5.29%, respectively.

To summarise the above, we output the average MAPE and sMAPE values for the automatic ARIMA, ETS, and TBATS models alongside their benchmark models (Theta and Damped Exponential Smoothing) to determine the best-performing model. The results are sorted in ascending order based on their combined performance in both MAPE and sMAPE (R code 8.41).

[3] Appendix 8.39 contains a comprehensive list of automatically fitted TBATS models for each series and their respective forecasted values.

Table 22: Error measures evaluating out-of-sample accuracy of the automatic models

Method	MAPE	sMAPE
Damped Exponential Smoothing	4.672529	4.539832
ETS	5.140505	4.936170
Theta	5.541910	5.291370
ARIMA	5.683726	5.370717
TBATS	6.156728	5.829611

Best model based on MAPE and sMAPE:

Method	MAPE	sMAPE
Damped Exponential Smoothing	4.672529	4.539832

The analysis reveals that the Damped Exponential Smoothing method emerges as the best model, boasting the lowest MAPE and sMAPE values of 4.67% and 4.54%, respectively. This indicates that, on average, this method provides the most accurate forecasts compared to the others evaluated.

Conversely, the TBATS method exhibits the highest MAPE (6.16%) and sMAPE (5.83%) values, indicating the least accurate forecasting performance among all the evaluated methods. The TBATS model might perform worse due to factors such as potential overfitting, violation of model assumptions, and limitations in historical data. These issues can collectively hinder the model's accuracy and effectiveness in forecasting.

6 Conclusions

This report has provided valuable insights into the performance and effectiveness of various forecasting methods for quarterly time series data.

Although the 1975 recession significantly impacted forecast accuracy, and the manual models struggled to anticipate the abrupt shifts in unemployment rates during this economic turmoil, the forecasts before the recession yielded promising results, with the regression model exhibiting superior accuracy.

The competitive edge of the Damped Exponential Smoothing model over automatic ARIMA, ETS, and TBATS models for batch forecasting can be attributed to the factor highlighted by Koning, Franses, Hibon and Stekler (2005) that the complexity of forecasting methods does not always correlate with forecast accuracy.

It is crucial to acknowledge the inherent limitations in forecasting, including the reliance on historical data and assumptions regarding stationarity and underlying patterns. Moving forward, continued research and experimentation are essential to refining forecasting methodologies and addressing the evolving challenges posed by dynamic and uncertain environments.

By leveraging the insights from this study, organisations can enhance their forecasting capabilities and make informed decisions to navigate the complexities of today's business landscape effectively. By strategically utilising forecasting techniques, businesses can optimise resource allocation, minimise risks, and seize opportunities for growth and innovation.

---

7 References

Bank of Canada (1999) *Canadian economic performance at the end of the twentieth century.* Available at: https://www.bankofcanada.ca/1999/06/canadian-economic-performance-end-twentieth-century/ (Accessed: 29 March 2024).

Brozyna J., Mentel G., Szetela B. (2016), 'Influence of double seasonality on economic forecasts on the example of energy demand', *Journal of International Studies*, Vol. 9, No 3, pp. 9-20. Available at: https://doi.org/10.14254/2071-8330.2016/9-3/1.

Koning, A.J., Franses, P.H., Hibon, M. and Stekler, H.O. (2005) 'The M3 competition: Statistical tests of the results', *International Journal of Forecasting*, 21(3), pp.397–409. Available at: https://doi.org/10.1016/j.ijforecast.2004.10.003.

Makridakis, S. and Hibon, M. (2000) 'The M3-Competition: results, conclusions and implications', *International Journal of Forecasting*, 16(4), pp.451–476. Available at: https://doi.org/10.1016/s0169-2070(00)00057-1.

8 Appendices

8.1 Code displaying series ID 1394 of the M3 competition data set

```
frequency <- 4 ## for quarterly time series
data <- M3[[1394]]
data <- subset(data, frequency == frequency)
cat("Table 1: M3 competition series ID 1394")
data
```

8.2 Codes producing a time series plot of the historical data (Figure 1) and its summary

```
# Assign the historical data to a variable for training the model
training_data <- data$x
# Assign the future data points for testing the model's predictions
test_data <- data$xx
```

```r
# Generate a time series plot of the training data
autoplot(training_data,
         type = "l",
         xlab = "Year",
         ylab = "Unemployment",
         main = "Quarterly unemployment in Canada in 1962-1973
         (Series ID 1394)")
```

```r
cat("Table 2: Summary of the quarterly unemployment in Canada in 1962-1973")
summary(training_data)
```

8.3 Codes producing the seasonality plot (Figure 2) and the seasonal subseries plot of the training data (Figure 3)

```r
ggseasonplot(training_data, year.labels=TRUE, year.labels.left=TRUE) +
  ylab("Unemployment") +
  ggtitle("Seasonality: quarterly unemployment in Canada")
```

```r
ggsubseriesplot(training_data) +
  ylab("Unemployment") +
  ggtitle("Seasonal subseries: quarterly unemployment in Canada")
```

8.4 Code producing the lagged scatter plots of the quarterly Canadian unemployment in 1962-1973 (Figure 4)

```r
gglagplot(training_data) +
  #ggtitle("Lagged scatter plot: quarterly unemployment") +
```

```r
    theme(legend.position = "bottom",
          axis.text.x = element_text(angle = 45, hjust = 1))
```

8.5 Code plotting the Autocorrelation Function (ACF) of the quarterly unemployment in Canada in 1962-1973 in Figure 5

```r
ggAcf(training_data, main = "ACF: unemployment in Canada in 1962-1973")
```

8.6 Code plotting multiplicative decomposition of the quarterly unemployment in Canada in 1962-1973 in Figure 6

```r
training_decomposed <- decompose(training_data, type = "multiplicative")
autoplot(training_decomposed) + xlab("Year")
```

8.7 Code producing box plots of unemployment in Canada in 1962-1973 per quarter in Figure 7 to detect outliers

```r
# Ensure the time series has the correct frequency set
training_ts <- ts(training_data, frequency = 4)

# Convert the time series to a data frame for plotting
# Create a factor indicating the quarter
df <- data.frame(
  Value = as.numeric(training_ts),
  Quarter = factor(rep(1:4, length.out = length(training_ts)))
)
```

```
ggplot(df, aes(x = Quarter, y = Value)) +
  geom_boxplot() +
  labs(title = "Distribution of unemployment in Canada in 1962-1973",
       x = "Quarter", y = "Unemployment")
```

8.8 Code fitting a polynomial regression model using the `tslm()` function

```
# Regression Model
regression_model <- tslm(training_data ~ trend +
                              I(trend^2) + I(trend^3) + season)
cat("Table 3: Regression model summary")
summary(regression_model)
```

8.9 Code plotting the training data and values fitted by the regression model in Figure 8

```
autoplot(training_data, series="Data") +
  autolayer(fitted(regression_model), series="Fitted") +
  xlab("Year") + ylab("Unemployment") +
  ggtitle("Regression model: historical vs fitted values") +
  guides(color = guide_legend(title = ""))
```

8.10 Code running the Shapiro-Wilk test checking the assumption of normality of the regression model's training residuals

```r
cat("Table 4: Shapiro-Wilk test of the regression model's training residuals")
shapiro.test(regression_model$residuals)
```

8.11 Code plotting training residuals from the regression model in Figure 9

```r
checkresiduals(regression_model)
```

8.12 Code running the Ljung-Box test detecting autocorrelation in the training residuals at lag 1

```r
# Perform Ljung-Box test on the residuals
ljung_box_test <- Box.test(regression_model$residuals, lag = 1,
                          type = "Ljung-Box")

# Print the results
cat("Table 5: Box-Ljung test of the regression model's training residuals")
ljung_box_test
```

8.13 Code plotting future (out-of-sample) data and values forecasted by the regression model in Figure 10

```r
# Forecast
forecast_regression <- forecast(regression_model, h = 8,
                                PI = TRUE, level = c(0.8, 0.95))
```

```r
# Plot the forecast and test data together
autoplot(training_data) +
  autolayer(forecast(regression_model, level = c(0.95)),
            series = "95% CI") +
      autolayer(forecast(regression_model, level = c(0.8)),
                series = "80% CI") +
  autolayer(test_data, color = "black", linetype = "dashed",
            series = "Future Data") +
  xlab("Year") +
  ylab("Unemployment") +
  ggtitle("Regression model: forecasts of unemployment in Canada") +
  guides(color = guide_legend(title = "Forecasts"),
         linetype = guide_legend(title = "Future Data"))
```

8.14 Code plotting out-of-sample residuals from the regression model in Figure 11

```r
residuals_regression <- forecast_regression$mean - test_data
checkresiduals(residuals_regression)
```

8.15 Code calculating measures, such as MAE, RMSE, and MAPE, to evaluate the accuracy of the regression model to forecast future data

```r
# Calculate evaluation metrics
mae_regression <- mean(abs(residuals_regression))
rmse_regression <- sqrt(mean(residuals_regression^2))
```

```r
mape_regression <- mean(abs(residuals_regression / test_data)) * 100
bias_regression <- mean(residuals_regression)

# Create a data frame for the metrics
evaluation_regression <- data.frame(
  Metric = c("Mean Absolute Error (MAE)",
             "Root Mean Squared Error (RMSE)",
             "Mean Absolute Percentage Error (MAPE)",
             "Forecast Bias"),
  Value = c(mae_regression,
            rmse_regression,
            mape_regression,
            bias_regression)
)

# Remove column names
colnames(evaluation_regression) <- NULL

# Print the data frame
cat("Table 6: Error measures evaluating the regression model's
    out-of-sample accuracy")
print(evaluation_regression, row.names = FALSE, col.names = FALSE)
```

8.16 Code fitting and plotting in Figure 12 the exponential smoothing model with the Holt-Winters method, incorporating multiplicative error, additive trend with damping, and multiplicative seasonality components (ETS(M,Ad,M))

```
# Fit the Holt-Winters model with multiplicative trend and seasonality
hw_model <- ets(training_data, model="MAM", damped=TRUE)
cat("Table 7: Exponential Smoothing model with
    the Holt-Winters method summary")
summary(hw_model)
```

```
autoplot(training_data, series="Data") +
  autolayer(fitted(hw_model), series="Fitted") +
  xlab("Year") + ylab("Unemployment") +
    ggtitle("ETS (M, Ad, M) model: historical vs fitted values") +
  guides(color = guide_legend(title = ""))
```

8.17 Code plotting training residuals of the exponential smoothing (ETS (M, Ad, M)) model in Figure 13

```
checkresiduals(hw_model)
```

8.18 Code running the Shapiro-Wilk test of the exponential smoothing model's training residuals

```r
# Test for normality
cat("Table 8: Shapiro-Wilk test of the exponential
    smoothing model's training residuals")
shapiro.test(hw_model$residuals)
```

8.19 Code plotting the forecast of the exponential smoothing model with the Holt-Winters method against future data in Figure 14

```r
# Forecast
forecast_hw <- forecast(hw_model, h = 8,
                        PI = TRUE, level = c(0.8, 0.95))

# Plot the forecast and test data together
autoplot(training_data) +
  autolayer(forecast(hw_model, level = c(0.95)),
            series = "95% CI") +
      autolayer(forecast(hw_model, level = c(0.8)),
                series = "80% CI") +
  autolayer(test_data, color = "black", linetype = "dashed",
            series = "Future Data") +
  xlab("Year") +
  ylab("Unemployment") +
  ggtitle("ETS(M,Ad,M) model: forecasts of unemployment in Canada") +
  guides(color = guide_legend(title = "Forecasts"),
         linetype = guide_legend(title = "Future Data"))
```

8.20 Code plotting out-of-sample residuals of the exponential smoothing (ETS (M, Ad, M)) model in Figure 15

```
# Calculate residuals
residuals_hw <- forecast_hw$mean - test_data
checkresiduals(residuals_hw)
```

8.21 Code calculating measures, such as MAE, RMSE, and MAPE, to evaluate the accuracy of the exponential smoothing (ETS (M, Ad, M)) model to forecast future data

```
# Calculate evaluation metrics
mae_hw <- mean(abs(residuals_hw))
rmse_hw <- sqrt(mean(residuals_hw^2))
mape_hw <- mean(abs(residuals_hw / test_data)) * 100
bias_hw <- mean(residuals_hw)

# Create a data frame for the metrics
evaluation_hw <- data.frame(
  Metric = c("Mean Absolute Error (MAE)",
             "Root Mean Squared Error (RMSE)",
             "Mean Absolute Percentage Error (MAPE)",
             "Forecast Bias"),
  Value = c(mae_hw, rmse_hw, mape_hw, bias_hw)
)

# Remove column names
colnames(evaluation_hw) <- NULL
```

```r
# Print the data frame
cat("Table 9: Error measures evaluating ETS(M,Ad,M) model's
    out-of-sample accuracy")
print(evaluation_hw, row.names = FALSE, col.names = FALSE)
```

8.22 Code plotting the Autocorrelation Function (ACF) in Figure 16

```r
acf(training_data, main = "ACF: unemployment in Canada in 1962-1973")
```

8.23 Code conducting the Augmented Dickey-Fuller (ADF) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests to determine the necessity of differencing

```r
library(tseries)
cat("Table 10: Augmented Dickey-Fuller (ADF) test of the training data")
adf.test(training_data, alternative = "stationary")
```

```r
library(urca)
cat("Table 11: Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test
    of the training data")
kpss.test(training_data)
```

8.24 Code determining the appropriate number of first and seasonal differencing for the training data

```
cat("Number of first differecings: ", ndiffs(training_data))

cat("Number of seasonal differecings: ", nsdiffs(training_data))
```

8.25 Code plotting the ACF/PACF functions for the differenced training data in Figure 17

```
training_diff <- diff(diff(training_data, differences = 1), lag = 4)

# Set up a multi-panel plot with 1 row and 2 columns
par(mfrow = c(1, 2))

# Plot ACF for differenced data
acf(training_diff, main = "Differenced unemployment")

# Plot PACF for differenced data
pacf(training_diff, main = "")
```

8.26 Codes plotting the differenced historical data in Figure 18 together with performing the ADF and the KPSS tests

```
cat("Table 12: Augmented Dickey-Fuller (ADF) test of the differenced data")
adf.test(training_diff, alternative = "stationary")
```

```r
cat("Table 13: Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test
    of the differenced data")
kpss.test(training_diff)
```

```r
# Plot Differenced Data
autoplot(training_diff)+
 ggtitle("Differenced unemployment in Canada in 1962-1973") +
    xlab("Year")+
    ylab("Differenced unemployment")+
  guides(color = guide_legend(title = ""))
```

8.27 Code fitting and plotting ARIMA(0,1,0)(1,1,0)[4] model in in Figure 19

```r
cat("Table 14: ARIMA(0,1,0)(1,1,0)[4] model summary")
arima_model <- Arima(training_data, order = c(0,1,0), seasonal = c(1,1,0))
summary(arima_model)
```

```r
autoplot(training_data, series="Data") +
  autolayer(fitted(arima_model), series="Fitted") +
  xlab("Year") + ylab("Unemployment") +
 ggtitle("ARIMA(0,1,0)(1,1,0)[4] model: historical vs fitted values") +
  guides(color = guide_legend(title = ""))
```

8.28 Code plotting residual analysis in Figure 20

```r
# Plot histogram of residuals
checkresiduals(arima_model)
```

8.29 Code conducting the Shapiro-Wilk test assessing the normality of the residuals from the ARIMA model

```
# Test for normality
cat("Table 15: Shapiro-Wilk test of the ARIMA model's training residuals")
shapiro.test(arima_model$residuals)
```

8.30 Code plotting ARIMA(0,1,0)(1,1,0)[4] model's eight-quarter forecast of unemployment in Canada in Figure 21

```
# Forecast
forecast_arima <- forecast(arima_model, h = 8,
                           PI = TRUE, level = c(0.8, 0.95))

# Plot the forecast and test data together
autoplot(training_data) +
  autolayer(forecast(arima_model, level = c(0.95)),
            series = "95% CI") +
      autolayer(forecast(arima_model, level = c(0.8)),
                series = "80% CI") +
  autolayer(test_data, color = "black", linetype = "dashed",
            series = "Future Data") +
  xlab("Year") +
  ylab("Unemployment") +
  ggtitle("ARIMA(0,1,0)(1,1,0)[4] model: forecasts of unemployment in
          Canada") +
  guides(color = guide_legend(title = "Forecasts"),
         linetype = guide_legend(title = "Future Data"))
```

8.31 Code conducting the Ljung-Box test and plotting the residual analysis in Figure 20

```
# Calculate residuals
residuals_arima <- forecast_arima$mean - test_data

checkresiduals(residuals_arima)
```

8.32 Code evaluating the ARIMA model's forecasting accuracy

```
# Calculate evaluation metrics
mae_arima <- mean(abs(residuals_arima))
rmse_arima <- sqrt(mean(residuals_arima^2))
mape_arima <- mean(abs(residuals_arima / test_data)) * 100
bias_arima <- mean(residuals_arima)

# Create a data frame for the metrics
evaluation_arima <- data.frame(
  Metric = c("Mean Absolute Error (MAE)", "Root Mean Squared Error (RMSE)",
             "Mean Absolute Percentage Error (MAPE)", "Forecast Bias"),
  Value = c(mae_arima, rmse_arima, mape_arima, bias_arima)
)

# Remove column names
colnames(evaluation_arima) <- NULL

# Print the data frame
cat("Table 16: Error measures evaluating the ARIMA model's
```

```r
    out-of-sample accuracy")
print(evaluation_arima, row.names = FALSE, col.names = FALSE)
```

8.33 Code comparing Mean Absolute Percentage Errors (MAPEs) among the three forecasting models

```r
# Store evaluation metrics for each model in a data frame
evaluation_metrics <- data.frame(
  Model = c("ARIMA", "Exponential Smoothing", "Regression"),
  MAE = c(mae_arima, mae_hw, mae_regression),
  RMSE = c(rmse_arima, rmse_hw, rmse_regression),
  MAPE = c(mape_arima, mape_hw, mape_regression),
  Bias = c(bias_arima, bias_hw, bias_regression)
)

# Print the evaluation metrics for comparison
cat("Table 17: Error measures evaluating
    out-of-sample accuracy of the three models")
print(evaluation_metrics, row.names = FALSE)

# Select the model with the lowest values for the evaluation metrics
best_model <- evaluation_metrics[which.min(evaluation_metrics$MAPE), ]

# Print the best model
cat("Best Model based on MAPE:", best_model$Model, "\n")
```

8.34 Code printing M3 competition series ID 1001

```
cat("Table 18: M3 competition series ID 1001")
M3[[1001]]
```

8.35 Code printing summaries of automatically fitted ARIMA models for each series (IDs 1001 to 1100) using `auto.arima()` function and printing respective forecasted values.

```
# Define the series IDs and criterion
ts_start <- 1001
ts_end <- 1100
criterion <- "aicc"
num_ts <- ts_end - ts_start + 1

# Initialize arrays to store MAPE and sMAPE for ARIMA and benchmarks
mape_arima <- numeric(num_ts)
mape_theta <- numeric(num_ts)
mape_damped <- numeric(num_ts)
smape_arima <- numeric(num_ts)
smape_theta <- numeric(num_ts)
smape_damped <- numeric(num_ts)

# Loop through each time series
for (s in ts_start:ts_end) {
  train_data <- M3[[s]]$x
  test_data <- M3[[s]]$xx
  h <- length(test_data)
```

```r
# Fit ARIMA model
arima_fit <- auto.arima(train_data, ic = criterion)
# Print summary of the fitted ARIMA model
cat("Summary for ARIMA model of Time Series ID:", s, "\n")
print(summary(arima_fit))
cat("\n")  # Add a newline after each summary

arima_fcst <- forecast(arima_fit, h = h)$mean
# Print forecasts
cat("Forecasts for Time Series ID:", s, "\n")
print(arima_fcst)
cat("\n")  # Add a newline after printing forecasts

# Calculate MAPE for ARIMA
mape_arima[s - ts_start + 1] <- 100 * mean(abs(test_data - arima_fcst) /
                                               test_data, na.rm = TRUE)
# Calculate sMAPE for ARIMA
smape_arima[s - ts_start + 1] <- 200 * mean(abs(test_data - arima_fcst) /
                                      (abs(test_data) + abs(arima_fcst)),
                                      na.rm = TRUE)

# Fit Theta model
theta_fit <- thetaf(train_data, h = h)
theta_fcst <- forecast(theta_fit)$mean
# Calculate MAPE for Theta
mape_theta[s - ts_start + 1] <- 100 * mean(abs(test_data - theta_fcst) /
                                               test_data, na.rm = TRUE)
# Calculate sMAPE for Theta
smape_theta[s - ts_start + 1] <- 200 * mean(abs(test_data - theta_fcst) /
                                      (abs(test_data) + abs(theta_fcst)),
```

```
                                          na.rm = TRUE)

  # Fit Damped Exponential Smoothing model
  tryCatch({
    damped_model <- ets(train_data, model = "ZZZ", damped = TRUE)
    damped_fcst <- forecast(damped_model, h = h)$mean
    # Calculate MAPE for Damped Exponential Smoothing
    mape_damped[s - ts_start + 1] <- 100 * mean(abs(test_data - damped_fcst) /
                                                test_data, na.rm = TRUE)
    # Calculate sMAPE for Damped Exponential Smoothing
    smape_damped[s - ts_start + 1] <- 200 * mean(abs(test_data - damped_fcst) /
                                          (abs(test_data) + abs(damped_fcst)),
                                          na.rm = TRUE)
  }, error = function(e) {
    mape_damped[s - ts_start + 1] <- NA  # Assign NA in case of error
    smape_damped[s - ts_start + 1] <- NA  # Assign NA in case of error
  })
}
```

```
Summary for ARIMA model of Time Series ID: 1001
Series: train_data
ARIMA(0,1,0)(0,0,2)[4] with drift

Coefficients:
        sma1     sma2    drift
      0.2285  -0.4830  80.6054
s.e.  0.1756   0.1934  14.4313

sigma^2 = 13956:  log likelihood = -266.13
AIC=540.26   AICc=541.31   BIC=547.31
```

```
Training set error measures:
                    ME     RMSE      MAE         MPE     MAPE     MASE
Training set 0.4883693 112.6361 93.57038 -0.09058363 1.927003 0.224302
                  ACF1
Training set 0.1312772

Forecasts for Time Series ID: 1001
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7117.925 7120.625 7067.545 7143.754
1992 7162.699 7255.612 7410.836 7444.435

Summary for ARIMA model of Time Series ID: 1002
Series: train_data
ARIMA(1,2,1)

Coefficients:
          ar1      ma1
      -0.5437  -0.8493
s.e.   0.1586   0.0899

sigma^2 = 13034:  log likelihood = -258.74
AIC=523.49   AICc=524.12   BIC=528.7

Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE       ACF1
Training set 34.36251 108.8543 84.01765 0.7305779 1.701211 0.3224008 0.08323809

Forecasts for Time Series ID: 1002
         Qtr1     Qtr2     Qtr3     Qtr4
```

```
1991 6768.023 6821.732 6923.182 6998.677
1992 7088.283 7170.218 7256.323 7340.161

Summary for ARIMA model of Time Series ID: 1003
Series: train_data
ARIMA(0,1,0)(0,0,1)[4] with drift

Coefficients:
         sma1    drift
      -0.2844  59.9585
s.e.   0.1900  19.2528

sigma^2 = 30222:  log likelihood = -281.96
AIC=569.92   AICc=570.54   BIC=575.2

Training set error measures:
                    ME     RMSE      MAE        MPE     MAPE      MASE
Training set -3.777574 167.8147 144.7328 -0.2736438 2.979931 0.4729445
                    ACF1
Training set -0.03416144

Forecasts for Time Series ID: 1003
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6693.121 6707.397 6750.804 6798.718
1992 6858.676 6918.635 6978.593 7038.551

Summary for ARIMA model of Time Series ID: 1004
Series: train_data
ARIMA(0,1,1) with drift
```

```
Coefficients:
          ma1    drift
      -0.7081  47.9676
s.e.   0.1228   7.2280

sigma^2 = 23127:  log likelihood = -276.39
AIC=558.77   AICc=559.39   BIC=564.06

Training set error measures:
                    ME     RMSE     MAE        MPE    MAPE      MASE
Training set -8.889888 146.8003 105.838 -0.2744015 2.24214 0.4717803
                     ACF1
Training set -0.009220295

Forecasts for Time Series ID: 1004
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5943.583 5991.551 6039.519 6087.486
1992 6135.454 6183.421 6231.389 6279.357

Summary for ARIMA model of Time Series ID: 1005
Series: train_data
ARIMA(2,1,0)(0,0,2)[4] with drift

Coefficients:
         ar1      ar2     sma1     sma2    drift
      1.0526  -0.6109  -0.2265  -0.4192  39.9323
s.e.  0.1378   0.1408   0.2012   0.1489   5.1292

sigma^2 = 1510:  log likelihood = -217.64
AIC=447.27   AICc=449.6   BIC=457.84
```

```
Training set error measures:
                   ME     RMSE      MAE         MPE      MAPE     MASE
Training set -1.71154 36.11749 29.85933 -0.05046774 0.6070018 0.129633
                   ACF1
Training set 0.08152119

Forecasts for Time Series ID: 1005
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5772.773 5825.686 5871.001 5905.261
1992 5941.759 6003.252 6049.594 6100.330

Summary for ARIMA model of Time Series ID: 1006
Series: train_data
ARIMA(0,1,0)(0,0,1)[4] with drift

Coefficients:
         sma1    drift
      -0.3865  38.0903
s.e.   0.1690  10.4176

sigma^2 = 11076:  log likelihood = -260.53
AIC=527.06   AICc=527.68   BIC=532.35

Training set error measures:
                    ME     RMSE      MAE        MPE     MAPE     MASE
Training set -5.579311 101.5898 83.71234 -0.1943286 1.675919 0.396248
                    ACF1
Training set -0.05585935
```

```
Forecasts for Time Series ID: 1006
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5961.932 5989.347 6101.629 6130.721
1992 6168.812 6206.902 6244.992 6283.083

Summary for ARIMA model of Time Series ID: 1007
Series: train_data
ARIMA(0,2,1)

Coefficients:
          ma1
      -0.6716
s.e.   0.1289

sigma^2 = 12701:  log likelihood = -257.83
AIC=519.65   AICc=519.96   BIC=523.13

Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE
Training set 8.336028 108.7886 91.86791 0.1708783 1.640634 0.2046227
                    ACF1
Training set -0.01489013

Forecasts for Time Series ID: 1007
         Qtr1     Qtr2     Qtr3     Qtr4
1991 8602.890 8756.281 8909.671 9063.061
1992 9216.452 9369.842 9523.233 9676.623

Summary for ARIMA model of Time Series ID: 1008
Series: train_data
```

```
ARIMA(3,1,0)

Coefficients:
         ar1     ar2      ar3
      0.2477  0.5048  -0.3184
s.e.  0.1479  0.1486   0.1629

sigma^2 = 37488:  log likelihood = -286.32
AIC=580.65   AICc=581.7   BIC=587.69

Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE
Training set 31.72793 184.6088 145.7247 0.6253843 2.916929 0.2942446
                    ACF1
Training set -0.06306129

Forecasts for Time Series ID: 1008
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6418.820 6197.354 6342.017 6215.821
1992 6328.086 6246.143 6322.687 6264.546

Summary for ARIMA model of Time Series ID: 1009
Series: train_data
ARIMA(0,2,1)

Coefficients:
          ma1
      -0.8892
s.e.   0.0754
```

```
sigma^2 = 18605:  log likelihood = -266.32
AIC=536.65   AICc=536.96   BIC=540.13

Training set error measures:
                   ME     RMSE      MAE      MPE     MAPE      MASE        ACF1
Training set 28.71826 131.6672 107.2456 0.555191 2.105124 0.3537417 -0.03056659

Forecasts for Time Series ID: 1009
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6960.367 7071.234 7182.101 7292.968
1992 7403.835 7514.702 7625.569 7736.436

Summary for ARIMA model of Time Series ID: 1010
Series: train_data
ARIMA(1,1,0) with drift

Coefficients:
         ar1    drift
      0.3514  66.3001
s.e.  0.1455  35.8439

sigma^2 = 24840:  log likelihood = -277.64
AIC=561.28   AICc=561.9   BIC=566.56

Training set error measures:
                   ME     RMSE      MAE         MPE     MAPE      MASE
Training set 1.134408 152.1383 111.4108 -0.05127389 2.356466 0.2405307
                    ACF1
Training set -0.03397648
```

```
Forecasts for Time Series ID: 1010
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6917.528 6954.212 7010.105 7072.747
1992 7137.762 7203.610 7269.751 7335.996

Summary for ARIMA model of Time Series ID: 1011
Series: train_data
ARIMA(0,1,0)

sigma^2 = 14107:  log likelihood = -92.94
AIC=187.88   AICc=188.19   BIC=188.59

Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE       ACF1
Training set 36.07297 115.0021 87.13547 0.6399447 1.597507 0.5349837 -0.2580519

Forecasts for Time Series ID: 1011
       Qtr1   Qtr2   Qtr3   Qtr4
1991 5739.5 5739.5 5739.5 5739.5
1992 5739.5 5739.5 5739.5 5739.5

Summary for ARIMA model of Time Series ID: 1012
Series: train_data
ARIMA(1,1,0)(0,0,1)[4] with drift

Coefficients:
          ar1     sma1    drift
      -0.6300  -0.3551  52.8290
s.e.   0.1196   0.1569  20.4517
```

```
sigma^2 = 104501:  log likelihood = -308.4
AIC=624.8   AICc=625.85   BIC=631.84

Training set error measures:
                    ME     RMSE      MAE        MPE     MAPE     MASE
Training set -13.61012 308.2227 236.3894 -0.7034427 4.490145 0.610175
                    ACF1
Training set -0.06968645

Forecasts for Time Series ID: 1012
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6634.043 6595.406 6876.293 6901.717
1992 6971.810 7013.763 7073.444 7121.957

Summary for ARIMA model of Time Series ID: 1013
Series: train_data
ARIMA(2,2,1)

Coefficients:
          ar1      ar2      ma1
      -0.4849  -0.4083  -0.7705
s.e.   0.1537   0.1475   0.1044

sigma^2 = 19673:  log likelihood = -266.84
AIC=541.68   AICc=542.76   BIC=548.63

Training set error measures:
                   ME    RMSE     MAE       MPE     MAPE      MASE       ACF1
Training set 30.49079 132.052 100.062 0.5904857 1.866572 0.3282739 -0.1018717
```

```
Forecasts for Time Series ID: 1013
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7399.821 7512.016 7596.888 7693.426
1992 7795.464 7890.072 7986.037 8084.377

Summary for ARIMA model of Time Series ID: 1014
Series: train_data
ARIMA(0,2,2)

Coefficients:
          ma1     ma2
      -1.1039  0.3653
s.e.   0.1997  0.1855

sigma^2 = 13147:  log likelihood = -258.41
AIC=522.81   AICc=523.44   BIC=528.02

Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE
Training set 30.25781 109.3252 83.93728 0.5180617 1.623024 0.3066342
                    ACF1
Training set -0.04093938

Forecasts for Time Series ID: 1014
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7610.891 7882.380 8153.869 8425.358
1992 8696.847 8968.337 9239.826 9511.315

Summary for ARIMA model of Time Series ID: 1015
Series: train_data
```

```
ARIMA(0,2,2)

Coefficients:
          ma1     ma2
      -1.1635  0.2761
s.e.   0.1587  0.1511

sigma^2 = 18705:  log likelihood = -266.11
AIC=538.21   AICc=538.84   BIC=543.42

Training set error measures:
                   ME     RMSE      MAE      MPE     MAPE      MASE        ACF1
Training set 29.96602 130.4006 101.4565 0.589516 1.995716 0.3333411 -0.03110622

Forecasts for Time Series ID: 1015
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7178.750 7282.606 7386.463 7490.320
1992 7594.177 7698.033 7801.890 7905.747

Summary for ARIMA model of Time Series ID: 1016
Series: train_data
ARIMA(0,2,1)

Coefficients:
          ma1
      -0.6704
s.e.   0.1601

sigma^2 = 43547:  log likelihood = -283.7
AIC=571.4   AICc=571.71   BIC=574.88
```

```
Training set error measures:
                    ME     RMSE      MAE        MPE     MAPE      MASE
Training set -1.402436 201.4393 144.5834 0.05395704 2.453735 0.2488954
                   ACF1
Training set 0.01952563

Forecasts for Time Series ID: 1016
         Qtr1     Qtr2     Qtr3     Qtr4
1991 9161.029 9224.558 9288.086 9351.615
1992 9415.144 9478.673 9542.201 9605.730

Summary for ARIMA model of Time Series ID: 1017
Series: train_data
ARIMA(0,2,3)

Coefficients:
          ma1     ma2     ma3
      -1.1959  0.1724  0.3253
s.e.   0.1600  0.2339  0.1480

sigma^2 = 12760:  log likelihood = -257.91
AIC=523.83   AICc=524.91   BIC=530.78

Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE       ACF1
Training set 12.95563 106.3494 83.85798 0.3205421 1.656687 0.3244179 0.01858664

Forecasts for Time Series ID: 1017
         Qtr1     Qtr2     Qtr3     Qtr4
```

```
1991 6643.737 6694.831 6706.303 6717.775
1992 6729.247 6740.719 6752.192 6763.664

Summary for ARIMA model of Time Series ID: 1018
Series: train_data
ARIMA(0,1,0)(0,0,1)[4] with drift

Coefficients:
         sma1    drift
      -0.5193  26.8908
s.e.   0.1812  12.8767

sigma^2 = 25506:  log likelihood = -278.77
AIC=563.54   AICc=564.16   BIC=568.83

Training set error measures:
                    ME     RMSE      MAE       MPE    MAPE      MASE       ACF1
Training set -2.084417 154.1652 126.3741 -0.100059 2.61344 0.4546853 0.02342655

Forecasts for Time Series ID: 1018
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5226.554 5259.397 5383.484 5366.804
1992 5393.695 5420.586 5447.476 5474.367

Summary for ARIMA model of Time Series ID: 1019
Series: train_data
ARIMA(0,1,0)

sigma^2 = 35083:  log likelihood = -286.02
AIC=574.04   AICc=574.14   BIC=575.8
```

```
Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE       ACF1
Training set 32.24425 185.1638 132.2215 0.5247727 2.595703 0.4864662 -0.1816933

Forecasts for Time Series ID: 1019
     Qtr1 Qtr2 Qtr3 Qtr4
1991 6161 6161 6161 6161
1992 6161 6161 6161 6161

Summary for ARIMA model of Time Series ID: 1020
Series: train_data
ARIMA(2,1,1) with drift

Coefficients:
         ar1      ar2     ma1    drift
      0.3794  -0.3337  0.7984  45.8223
s.e.  0.1533   0.1556  0.0826  13.1120

sigma^2 = 2304:  log likelihood = -226.45
AIC=462.9   AICc=464.53   BIC=471.71

Training set error measures:
                    ME     RMSE      MAE         MPE      MAPE     MASE
Training set -0.160375 45.18675 39.07145 -0.02445029 0.7717598 0.159679
                   ACF1
Training set 0.06658931

Forecasts for Time Series ID: 1020
         Qtr1     Qtr2     Qtr3     Qtr4
```

```
1991 6338.542 6415.428 6481.472 6524.599
1992 6562.651 6606.424 6654.063 6701.258

Summary for ARIMA model of Time Series ID: 1021
Series: train_data
ARIMA(0,1,0) with drift

Coefficients:
        drift
      57.0698
s.e.  24.5722

sigma^2 = 26582:  log likelihood = -279.55
AIC=563.1   AICc=563.4   BIC=566.62

Training set error measures:
                     ME     RMSE      MAE        MPE     MAPE      MASE
Training set 0.09900973 159.2902 129.5197 -0.1502942 2.587729 0.3523747
                  ACF1
Training set 0.1975923

Forecasts for Time Series ID: 1021
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6924.570 6981.640 7038.709 7095.779
1992 7152.849 7209.919 7266.988 7324.058

Summary for ARIMA model of Time Series ID: 1022
Series: train_data
ARIMA(0,1,0) with drift
```

```
Coefficients:
        drift
      63.1163
s.e.  18.6335

sigma^2 = 15286:  log likelihood = -267.65
AIC=539.31   AICc=539.61   BIC=542.83

Training set error measures:
                     ME     RMSE      MAE         MPE     MAPE      MASE
Training set 0.07567914 120.7926 97.31247 -0.08623549 2.283608 0.3125501
                  ACF1
Training set 0.1971945

Forecasts for Time Series ID: 1022
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6170.116 6233.233 6296.349 6359.465
1992 6422.581 6485.698 6548.814 6611.930

Summary for ARIMA model of Time Series ID: 1023
Series: train_data
ARIMA(0,1,1) with drift

Coefficients:
          ma1     drift
      -0.5414  130.6034
s.e.   0.1206    7.4191

sigma^2 = 11152:  log likelihood = -260.53
AIC=527.06   AICc=527.67   BIC=532.34
```

```
Training set error measures:
                    ME     RMSE      MAE        MPE    MAPE      MASE
Training set -1.027825 101.9386 80.11251 -0.2201263 1.62209 0.1530398
                    ACF1
Training set -0.04368728

Forecasts for Time Series ID: 1023
         Qtr1     Qtr2     Qtr3     Qtr4
1991 8454.130 8584.733 8715.337 8845.940
1992 8976.544 9107.147 9237.751 9368.354

Summary for ARIMA model of Time Series ID: 1024
Series: train_data
ARIMA(2,1,0) with drift

Coefficients:
         ar1     ar2    drift
      0.1972  0.2837  59.4453
s.e.  0.1454  0.1473  27.6363

sigma^2 = 10089:  log likelihood = -257.79
AIC=523.59   AICc=524.64   BIC=530.63

Training set error measures:
                     ME     RMSE      MAE        MPE     MAPE      MASE
Training set -0.4421622 95.76836 70.97219 0.01786373 2.338031 0.2161184
                   ACF1
Training set 0.05546528
```

```
Forecasts for Time Series ID: 1024
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4191.713 4199.432 4232.240 4271.756
1992 4319.713 4371.238 4425.862 4482.110

Summary for ARIMA model of Time Series ID: 1025
Series: train_data
ARIMA(0,1,0)(0,0,1)[4] with drift

Coefficients:
         sma1     drift
      -0.4246  125.9893
s.e.   0.1751   21.3861

sigma^2 = 53019:  log likelihood = -294.27
AIC=594.55   AICc=595.16   BIC=599.83

Training set error measures:
                    ME     RMSE      MAE        MPE     MAPE      MASE
Training set -9.606145 222.2708 186.2137 -0.9578391 4.169168 0.3443937
                    ACF1
Training set -0.02747998

Forecasts for Time Series ID: 1025
         Qtr1     Qtr2     Qtr3     Qtr4
1991 8183.287 8247.646 8448.793 8492.918
1992 8618.907 8744.897 8870.886 8996.875

Summary for ARIMA model of Time Series ID: 1026
Series: train_data
```

```
ARIMA(0,1,0)(0,0,1)[4] with drift

Coefficients:
         sma1     drift
      -0.5429  134.4909
s.e.   0.2575   18.5847

sigma^2 = 54964:  log likelihood = -295.35
AIC=596.7   AICc=597.31   BIC=601.98

Training set error measures:
                    ME     RMSE      MAE       MPE     MAPE      MASE      ACF1
Training set -7.400008 226.3101 176.4199 -0.573544 3.336576 0.2875688 0.1038798

Forecasts for Time Series ID: 1026
         Qtr1     Qtr2     Qtr3     Qtr4
1991 8199.949 8557.742 8692.271 8963.051
1992 9097.542 9232.033 9366.524 9501.015

Summary for ARIMA model of Time Series ID: 1027
Series: train_data
ARIMA(0,2,1)(0,0,1)[4]

Coefficients:
          ma1     sma1
      -0.5880  -0.5218
s.e.   0.1194   0.2534

sigma^2 = 5272:  log likelihood = -239.45
AIC=484.91   AICc=485.54   BIC=490.12
```

```
Training set error measures:
                   ME    RMSE      MAE       MPE      MAPE       MASE
Training set 5.925756 69.2288 51.64031 0.1390986 0.8523613 0.08381976
                   ACF1
Training set -0.1124585

Forecasts for Time Series ID: 1027
          Qtr1      Qtr2      Qtr3      Qtr4
1991  9648.585  9739.625  9953.397 10105.212
1992 10251.878 10398.544 10545.209 10691.875

Summary for ARIMA model of Time Series ID: 1028
Series: train_data
ARIMA(0,1,0) with drift

Coefficients:
        drift
      34.2535
s.e.   6.0451

sigma^2 = 1609:  log likelihood = -219.25
AIC=442.5   AICc=442.8   BIC=446.02

Training set error measures:
                     ME     RMSE      MAE          MPE      MAPE      MASE
Training set 0.08871692 39.19161 29.66007 -0.003009321 0.6356089 0.2071704
                   ACF1
Training set -0.1234328
```

```
Forecasts for Time Series ID: 1028
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5444.953 5479.207 5513.460 5547.714
1992 5581.967 5616.221 5650.474 5684.728

Summary for ARIMA model of Time Series ID: 1029
Series: train_data
ARIMA(0,1,1)(0,0,1)[4] with drift

Coefficients:
          ma1     sma1    drift
      -0.5317  -0.3712  58.4123
s.e.   0.1191   0.1953   5.4719

sigma^2 = 13243:  log likelihood = -264.01
AIC=536.02   AICc=537.08   BIC=543.07

Training set error measures:
                  ME     RMSE      MAE         MPE     MAPE      MASE
Training set -1.4582 109.7227 89.16849 -0.07457864 1.368103 0.3391565
                    ACF1
Training set -0.05974379

Forecasts for Time Series ID: 1029
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7994.186 7986.191 8145.252 8187.925
1992 8238.434 8296.847 8355.259 8413.671

Summary for ARIMA model of Time Series ID: 1030
Series: train_data
```

```
ARIMA(0,1,0)(2,0,1)[4] with drift

Coefficients:
        sar1     sar2     sma1    drift
      0.1609  -0.4500  -0.5228  25.7383
s.e.  0.2301   0.1576   0.2413   6.9896

sigma^2 = 11359:  log likelihood = -261.4
AIC=532.79   AICc=534.42   BIC=541.6

Training set error measures:
                    ME     RMSE      MAE        MPE     MAPE      MASE
Training set 0.3749715 100.3386 75.37939 -0.0441398 1.959546 0.2600186
                  ACF1
Training set 0.1810952

Forecasts for Time Series ID: 1030
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4075.200 4181.230 4209.971 4361.282
1992 4358.938 4513.409 4557.154 4668.775

Summary for ARIMA model of Time Series ID: 1031
Series: train_data
ARIMA(0,1,0)(1,0,0)[4] with drift

Coefficients:
         sar1    drift
      -0.3220  80.1032
s.e.   0.1434  26.6991
```

```
sigma^2 = 53621:  log likelihood = -294.34
AIC=594.68   AICc=595.29   BIC=599.96

Training set error measures:
                    ME     RMSE      MAE        MPE     MAPE      MASE
Training set -4.141351 223.5295 175.8924 -0.3370834 3.149706 0.3861313
                   ACF1
Training set -0.1491866

Forecasts for Time Series ID: 1031
         Qtr1     Qtr2     Qtr3     Qtr4
1991 8171.936 8225.184 8300.652 8326.850
1992 8426.489 8515.240 8596.836 8694.297

Summary for ARIMA model of Time Series ID: 1032
Series: train_data
ARIMA(3,1,0)

Coefficients:
         ar1     ar2      ar3
      0.2477  0.5049  -0.3184
s.e.  0.1479  0.1486   0.1630

sigma^2 = 59112:  log likelihood = -296.12
AIC=600.23   AICc=601.28   BIC=607.28

Training set error measures:
                  ME    RMSE      MAE       MPE     MAPE      MASE        ACF1
Training set 39.8385 231.814 182.9496 0.6253116 2.915743 0.2941489 -0.06313375
```

```
Forecasts for Time Series ID: 1032
         Qtr1     Qtr2     Qtr3     Qtr4
1991 8061.399 7783.052 7964.868 7806.198
1992 7947.313 7844.269 7940.511 7867.395

Summary for ARIMA model of Time Series ID: 1033
Series: train_data
ARIMA(0,1,0)(0,0,1)[4] with drift

Coefficients:
         sma1    drift
      -0.3303  62.7418
s.e.   0.1773   8.5625

sigma^2 = 6540:  log likelihood = -249.11
AIC=504.22   AICc=504.84   BIC=509.5

Training set error measures:
                     ME    RMSE      MAE         MPE      MAPE      MASE
Training set -0.5302771 78.0646 64.82659 -0.02958115 0.8345742 0.2329378
                  ACF1
Training set 0.1414672

Forecasts for Time Series ID: 1033
         Qtr1     Qtr2     Qtr3     Qtr4
1991 9275.328 9347.047 9460.370 9544.838
1992 9607.580 9670.322 9733.063 9795.805

Summary for ARIMA model of Time Series ID: 1034
Series: train_data
```

```
ARIMA(1,1,0) with drift

Coefficients:
          ar1    drift
      -0.3061  63.9036
s.e.   0.1468   4.5796

sigma^2 = 1594:  log likelihood = -218.58
AIC=443.16   AICc=443.78   BIC=448.44

Training set error measures:
                     ME     RMSE      MAE        MPE      MAPE      MASE
Training set -0.2603967 38.54157 32.18771 0.02550812 0.8616422 0.1268794
                   ACF1
Training set 0.05804836

Forecasts for Time Series ID: 1034
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5319.874 5381.491 5446.094 5509.783
1992 5573.753 5637.636 5701.546 5765.447

Summary for ARIMA model of Time Series ID: 1035
Series: train_data
ARIMA(1,1,0) with drift

Coefficients:
         ar1    drift
      0.3809  63.6306
s.e.  0.1393   7.9356
```

```
sigma^2 = 1118:  log likelihood = -210.98
AIC=427.97   AICc=428.58   BIC=433.25

Training set error measures:
                    ME     RMSE      MAE        MPE      MAPE       MASE
Training set 0.2286188 32.27915 23.72794 0.01258423 0.6368267 0.08951829
                    ACF1
Training set -0.06664814

Forecasts for Time Series ID: 1035
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5125.914 5186.986 5249.642 5312.902
1992 5376.391 5439.968 5503.578 5567.201

Summary for ARIMA model of Time Series ID: 1036
Series: train_data
ARIMA(0,1,0) with drift

Coefficients:
        drift
      45.6744
s.e.  14.1718

sigma^2 = 8842:  log likelihood = -255.88
AIC=515.77   AICc=516.07   BIC=519.29

Training set error measures:
                     ME     RMSE      MAE        MPE     MAPE      MASE
Training set 0.06789373 91.86964 70.20584 -0.0334733 1.724436 0.3384026
                   ACF1
```

```
Training set 0.04289913

Forecasts for Time Series ID: 1036
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5042.674 5088.349 5134.023 5179.698
1992 5225.372 5271.047 5316.721 5362.395

Summary for ARIMA model of Time Series ID: 1037
Series: train_data
ARIMA(0,1,0) with drift

Coefficients:
        drift
      53.2907
s.e.  21.3039

sigma^2 = 19981:  log likelihood = -273.41
AIC=550.82   AICc=551.12   BIC=554.35

Training set error measures:
                     ME     RMSE      MAE         MPE     MAPE      MASE
Training set 0.06602745 138.1031 97.32818 -0.02552952 2.198919 0.3513653
                   ACF1
Training set 0.04782918

Forecasts for Time Series ID: 1037
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5303.291 5356.581 5409.872 5463.163
1992 5516.453 5569.744 5623.035 5676.326
```

```
Summary for ARIMA model of Time Series ID: 1038
Series: train_data
ARIMA(0,2,1)(0,0,1)[4]

Coefficients:
          ma1     sma1
      -0.6450  -0.4471
s.e.   0.1527   0.1660

sigma^2 = 1653:  log likelihood = -214.98
AIC=435.95   AICc=436.59   BIC=441.17

Training set error measures:
                   ME     RMSE      MAE        MPE      MAPE       MASE
Training set 2.284332 38.76018 27.38028 0.06819027 0.9079859 0.08923163
                   ACF1
Training set 0.00201347

Forecasts for Time Series ID: 1038
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4902.752 4957.846 5068.902 5163.734
1992 5247.777 5331.820 5415.863 5499.906

Summary for ARIMA model of Time Series ID: 1039
Series: train_data
ARIMA(0,1,0) with drift

Coefficients:
         drift
      112.5395
```

```
s.e.   16.9446

sigma^2 = 12640:  log likelihood = -263.57
AIC=531.14   AICc=531.44   BIC=534.66

Training set error measures:
                     ME     RMSE      MAE        MPE     MAPE      MASE
Training set 0.05085135 109.8439 87.08764 -0.2795087 2.120308 0.1852101
                 ACF1
Training set 0.120956

Forecasts for Time Series ID: 1039
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7301.740 7414.279 7526.819 7639.358
1992 7751.898 7864.437 7976.977 8089.516

Summary for ARIMA model of Time Series ID: 1040
Series: train_data
ARIMA(0,1,1) with drift

Coefficients:
          ma1    drift
      -0.2848  89.5719
s.e.   0.1664  15.3265

sigma^2 = 20119:  log likelihood = -273.08
AIC=552.17   AICc=552.78   BIC=557.45

Training set error measures:
                    ME     RMSE      MAE         MPE     MAPE       MASE         ACF1
```

```
Training set -1.439028 136.919 103.322 -0.4107154 2.948882 0.2650386 0.02422386

Forecasts for Time Series ID: 1040
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5665.658 5755.229 5844.801 5934.373
1992 6023.945 6113.517 6203.089 6292.661

Summary for ARIMA model of Time Series ID: 1041
Series: train_data
ARIMA(0,2,1)(0,0,1)[4]

Coefficients:
          ma1     sma1
      -0.5880  -0.5218
s.e.   0.1194   0.2534

sigma^2 = 5272:  log likelihood = -239.45
AIC=484.91   AICc=485.54   BIC=490.12

Training set error measures:
                   ME    RMSE      MAE       MPE      MAPE       MASE
Training set 5.925756 69.2288 51.64031 0.1390986 0.8523613 0.08381976
                   ACF1
Training set -0.1124585

Forecasts for Time Series ID: 1041
          Qtr1      Qtr2      Qtr3      Qtr4
1991  9648.585  9739.625  9953.397 10105.212
1992 10251.878 10398.544 10545.209 10691.875
```

```
Summary for ARIMA model of Time Series ID: 1042
Series: train_data
ARIMA(0,1,0)

sigma^2 = 212232:  log likelihood = -324.72
AIC=651.44   AICc=651.54   BIC=653.2

Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE       ACF1
Training set 47.35395 455.4216 262.7176 0.5147982 5.554388 0.4001791 -0.1424063

Forecasts for Time Series ID: 1042
     Qtr1 Qtr2 Qtr3 Qtr4
1991 5654 5654 5654 5654
1992 5654 5654 5654 5654

Summary for ARIMA model of Time Series ID: 1043
Series: train_data
ARIMA(0,2,1)

Coefficients:
          ma1
      -0.6939
s.e.   0.1405

sigma^2 = 4903:  log likelihood = -237.86
AIC=479.73   AICc=480.04   BIC=483.2

Training set error measures:
                  ME     RMSE      MAE       MPE      MAPE      MASE
```

```
Training set 2.15914 67.58971 51.57152 0.0871844 0.8848716 0.0856147
                     ACF1
Training set -0.004330942

Forecasts for Time Series ID: 1043
          Qtr1      Qtr2      Qtr3      Qtr4
1991  9385.632  9506.364  9627.096  9747.828
1992  9868.561  9989.293 10110.025 10230.757

Summary for ARIMA model of Time Series ID: 1044
Series: train_data
ARIMA(0,2,1)(0,0,1)[4]

Coefficients:
          ma1     sma1
      -0.5880  -0.5218
s.e.   0.1194   0.2534

sigma^2 = 5272:  log likelihood = -239.45
AIC=484.91   AICc=485.54   BIC=490.12

Training set error measures:
                   ME    RMSE      MAE       MPE      MAPE       MASE
Training set 5.925756 69.2288 51.64031 0.1390986 0.8523613 0.08381976
                   ACF1
Training set -0.1124585

Forecasts for Time Series ID: 1044
          Qtr1      Qtr2      Qtr3      Qtr4
1991  9648.585  9739.625  9953.397 10105.212
```

```
1992 10251.878 10398.544 10545.209 10691.875

Summary for ARIMA model of Time Series ID: 1045
Series: train_data
ARIMA(0,1,0)(1,0,0)[4]

Coefficients:
         sar1
      -0.4692
s.e.   0.1280

sigma^2 = 204798:  log likelihood = -323.95
AIC=651.89   AICc=652.19   BIC=655.41

Training set error measures:
                   ME    RMSE      MAE       MPE     MAPE     MASE       ACF1
Training set 63.75348 442.141 265.5665 0.6787665 4.498399 0.377923 -0.1154057

Forecasts for Time Series ID: 1045
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7230.163 7239.547 7178.553 7082.839
1992 7126.866 7122.463 7151.081 7195.988

Summary for ARIMA model of Time Series ID: 1046
Series: train_data
ARIMA(0,1,0) with drift

Coefficients:
        drift
      58.5628
```

```
s.e.  11.5963

sigma^2 = 5921:  log likelihood = -247.26
AIC=498.52   AICc=498.82   BIC=502.04

Training set error measures:
                    ME     RMSE     MAE          MPE      MAPE      MASE
Training set 0.1429894 75.17865 63.3376 -0.008959971 0.8405378 0.2466417
                  ACF1
Training set 0.1840323

Forecasts for Time Series ID: 1046
         Qtr1     Qtr2     Qtr3     Qtr4
1991 8926.863 8985.426 9043.988 9102.551
1992 9161.114 9219.677 9278.240 9336.802

Summary for ARIMA model of Time Series ID: 1047
Series: train_data
ARIMA(0,1,0)(0,0,1)[4] with drift

Coefficients:
         sma1    drift
      -0.3303  62.7418
s.e.   0.1773   8.5625

sigma^2 = 6540:  log likelihood = -249.11
AIC=504.22   AICc=504.84   BIC=509.5

Training set error measures:
                     ME    RMSE      MAE          MPE      MAPE      MASE
```

```
Training set -0.5302771 78.0646 64.82659 -0.02958115 0.8345742 0.2329378
                  ACF1
Training set 0.1414672

Forecasts for Time Series ID: 1047
         Qtr1     Qtr2     Qtr3     Qtr4
1991 9275.328 9347.047 9460.370 9544.838
1992 9607.580 9670.322 9733.063 9795.805

Summary for ARIMA model of Time Series ID: 1048
Series: train_data
ARIMA(0,2,0)(0,0,1)[4]

Coefficients:
         sma1
      -0.4750
s.e.   0.1875

sigma^2 = 491.6:  log likelihood = -189.74
AIC=383.48   AICc=383.79   BIC=386.96

Training set error measures:
                    ME     RMSE      MAE        MPE      MAPE      MASE
Training set 0.8452872 21.40274 15.68487 0.03534527 0.3414403 0.0335335
                   ACF1
Training set 0.09859012

Forecasts for Time Series ID: 1048
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7339.968 7449.473 7555.190 7661.152
```

```
1992 7767.115 7873.078 7979.041 8085.003

Summary for ARIMA model of Time Series ID: 1049
Series: train_data
ARIMA(2,0,0)(2,1,0)[4]

Coefficients:
         ar1      ar2     sar1     sar2
      1.4031  -0.4443  -0.9947  -0.5872
s.e.  0.1616   0.1596   0.1387   0.1274

sigma^2 = 23792:  log likelihood = -259.78
AIC=529.57   AICc=531.33   BIC=538.01

Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE       ACF1
Training set 19.53409 139.5198 108.5423 0.9812794 4.679077 0.3441908 -0.0568332

Forecasts for Time Series ID: 1049
         Qtr1     Qtr2     Qtr3     Qtr4
1991 3173.379 3027.413 3663.011 4232.519
1992 3525.396 3340.667 3740.827 4100.521

Summary for ARIMA model of Time Series ID: 1050
Series: train_data
ARIMA(1,1,0)(0,0,1)[4] with drift

Coefficients:
          ar1    sma1    drift
      -0.2745  0.3009  50.8185
```

```
s.e.   0.1542  0.1581  25.1775

sigma^2 = 28913:  log likelihood = -280.54
AIC=569.08   AICc=570.13   BIC=576.12

Training set error measures:
                    ME     RMSE      MAE         MPE     MAPE      MASE
Training set 0.9164337 162.1265 119.1677 -0.02402529 3.823502 0.3793943
                      ACF1
Training set -0.0009110078

Forecasts for Time Series ID: 1050
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4170.698 4191.026 4224.506 4182.610
1992 4258.878 4302.711 4355.447 4405.739

Summary for ARIMA model of Time Series ID: 1051
Series: train_data
ARIMA(0,1,0) with drift

Coefficients:
        drift
      57.7767
s.e.  16.1704

sigma^2 = 11511:  log likelihood = -261.56
AIC=527.11   AICc=527.41   BIC=530.64

Training set error measures:
                     ME     RMSE       MAE         MPE     MAPE      MASE
```

```
Training set 0.02830961 104.8248 76.44247 -0.0614075 2.840399 0.2427477
                  ACF1
Training set 0.2252838

Forecasts for Time Series ID: 1051
         Qtr1     Qtr2     Qtr3     Qtr4
1991 3845.577 3903.353 3961.130 4018.907
1992 4076.684 4134.460 4192.237 4250.014

Summary for ARIMA model of Time Series ID: 1052
Series: train_data
ARIMA(2,1,0) with drift

Coefficients:
         ar1     ar2    drift
      0.1972  0.2837  59.4453
s.e.  0.1454  0.1473  27.6363

sigma^2 = 10089:  log likelihood = -257.79
AIC=523.59   AICc=524.64   BIC=530.63

Training set error measures:
                     ME     RMSE      MAE        MPE     MAPE      MASE
Training set -0.4421622 95.76836 70.97219 0.01786373 2.338031 0.2161184
                   ACF1
Training set 0.05546528

Forecasts for Time Series ID: 1052
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4191.713 4199.432 4232.240 4271.756
```

```
1992 4319.713 4371.238 4425.862 4482.110

Summary for ARIMA model of Time Series ID: 1053
Series: train_data
ARIMA(0,1,3) with drift

Coefficients:
         ma1     ma2     ma3    drift
      0.2667  0.5529  0.5671  65.2721
s.e.  0.1304  0.1024  0.1253  38.6428

sigma^2 = 13148:  log likelihood = -263.84
AIC=537.67   AICc=539.29   BIC=546.48

Training set error measures:
                    ME     RMSE      MAE       MPE     MAPE      MASE
Training set -2.410205 107.9546 78.48924 -0.100184 2.820853 0.1888917
                   ACF1
Training set 0.09853504

Forecasts for Time Series ID: 1053
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4407.464 4421.851 4415.620 4480.892
1992 4546.164 4611.436 4676.708 4741.980

Summary for ARIMA model of Time Series ID: 1054
Series: train_data
ARIMA(0,1,1) with drift

Coefficients:
```

```
         ma1     drift
      0.5320  135.0805
s.e.  0.1876   63.8239

sigma^2 = 79316:  log likelihood = -302.7
AIC=611.4   AICc=612.02   BIC=616.69

Training set error measures:
                    ME     RMSE      MAE        MPE    MAPE      MASE
Training set 0.9926209 271.8606 202.2466 -0.2244582 4.54793 0.2525873
                    ACF1
Training set -0.07402446

Forecasts for Time Series ID: 1054
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7652.834 7787.915 7922.995 8058.076
1992 8193.157 8328.237 8463.318 8598.398

Summary for ARIMA model of Time Series ID: 1055
Series: train_data
ARIMA(0,1,0) with drift

Coefficients:
        drift
      96.0233
s.e.  41.8722

sigma^2 = 77186:  log likelihood = -302.47
AIC=608.94   AICc=609.24   BIC=612.46
```

```
Training set error measures:
                     ME     RMSE      MAE         MPE     MAPE     MASE
Training set 0.05163581 271.4363 203.4872 -0.04806934 4.168812 0.338581
                   ACF1
Training set 0.01781899

Forecasts for Time Series ID: 1055
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6593.023 6689.047 6785.070 6881.093
1992 6977.116 7073.140 7169.163 7265.186

Summary for ARIMA model of Time Series ID: 1056
Series: train_data
ARIMA(1,1,0)(0,0,1)[4]

Coefficients:
         ar1     sma1
      0.6211  -0.4253
s.e.  0.1266   0.1736

sigma^2 = 152028:  log likelihood = -317.1
AIC=640.2   AICc=640.82   BIC=645.49

Training set error measures:
                   ME     RMSE      MAE      MPE     MAPE      MASE        ACF1
Training set 67.83083 376.3808 239.4053 1.745091 5.009403 0.2262542 -0.04616856

Forecasts for Time Series ID: 1056
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5891.573 5893.367 6207.715 6234.560
```

```
1992 6251.235 6261.592 6268.024 6272.020

Summary for ARIMA model of Time Series ID: 1057
Series: train_data
ARIMA(2,1,0)

Coefficients:
         ar1     ar2
      0.4165  0.3075
s.e.  0.1418  0.1440

sigma^2 = 39024:  log likelihood = -287.61
AIC=581.22   AICc=581.84   BIC=586.51

Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE
Training set 29.74294 190.6926 154.8829 0.7112113 2.963211 0.2096979
                    ACF1
Training set 0.002323646

Forecasts for Time Series ID: 1057
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7871.843 7811.325 7765.618 7727.968
1992 7698.229 7674.263 7655.135 7639.797

Summary for ARIMA model of Time Series ID: 1058
Series: train_data
ARIMA(0,1,0)

sigma^2 = 47532:  log likelihood = -292.55
```

```
AIC=587.1   AICc=587.2   BIC=588.86

Training set error measures:
                   ME     RMSE      MAE          MPE     MAPE      MASE
Training set 5.856591 215.5261 164.9475 -0.006475213 4.251634 0.5993732
                   ACF1
Training set -0.3069186

Forecasts for Time Series ID: 1058
     Qtr1 Qtr2 Qtr3 Qtr4
1991 3944 3944 3944 3944
1992 3944 3944 3944 3944

Summary for ARIMA model of Time Series ID: 1059
Series: train_data
ARIMA(0,1,0)

sigma^2 = 15843:  log likelihood = -268.93
AIC=539.86   AICc=539.96   BIC=541.62

Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE    ACF1
Training set 20.61896 124.4323 99.21896 0.5686739 2.871105 0.3343971 0.20434

Forecasts for Time Series ID: 1059
       Qtr1   Qtr2   Qtr3   Qtr4
1991 3738.8 3738.8 3738.8 3738.8
1992 3738.8 3738.8 3738.8 3738.8

Summary for ARIMA model of Time Series ID: 1060
```

```
Series: train_data
ARIMA(0,1,0)(2,0,1)[4] with drift

Coefficients:
        sar1     sar2     sma1    drift
      0.1609  -0.4500  -0.5228  25.7383
s.e.  0.2301   0.1576   0.2413   6.9896

sigma^2 = 11359:  log likelihood = -261.4
AIC=532.79   AICc=534.42   BIC=541.6

Training set error measures:
                    ME     RMSE      MAE        MPE     MAPE      MASE
Training set 0.3749715 100.3386 75.37939 -0.0441398 1.959546 0.2600186
                  ACF1
Training set 0.1810952

Forecasts for Time Series ID: 1060
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4075.200 4181.230 4209.971 4361.282
1992 4358.938 4513.409 4557.154 4668.775

Summary for ARIMA model of Time Series ID: 1061
Series: train_data
ARIMA(2,0,1) with non-zero mean

Coefficients:
         ar1      ar2      ma1      mean
      1.7525  -0.8611  -0.5976  4139.280
s.e.  0.0996   0.0897   0.1640    90.236
```

```
sigma^2 = 25806:  log likelihood = -285.14
AIC=580.27   AICc=581.85   BIC=589.19

Training set error measures:
                   ME     RMSE      MAE         MPE     MAPE      MASE
Training set 4.330899 153.1657 124.2396 -0.03522399 2.958577 0.2609254
                    ACF1
Training set -0.04399749

Forecasts for Time Series ID: 1061
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4093.760 3996.891 3928.940 3893.268
1992 3889.260 3912.953 3957.925 4016.338

Summary for ARIMA model of Time Series ID: 1062
Series: train_data
ARIMA(0,1,1)

Coefficients:
         ma1
      0.4351
s.e.  0.1895

sigma^2 = 114886:  log likelihood = -311.12
AIC=626.25   AICc=626.55   BIC=629.77

Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE
Training set 57.38214 331.1554 254.7715 0.9726094 4.417362 0.3322529
```

```
                    ACF1
Training set -0.08880246

Forecasts for Time Series ID: 1062
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7393.124 7393.124 7393.124 7393.124
1992 7393.124 7393.124 7393.124 7393.124

Summary for ARIMA model of Time Series ID: 1063
Series: train_data
ARIMA(0,1,0)

sigma^2 = 115327:  log likelihood = -311.61
AIC=625.22   AICc=625.31   BIC=626.98

Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE
Training set 47.12059 335.7166 254.3479 0.7311856 4.384744 0.3790156
                    ACF1
Training set 0.003645485

Forecasts for Time Series ID: 1063
     Qtr1 Qtr2 Qtr3 Qtr4
1991 6375 6375 6375 6375
1992 6375 6375 6375 6375

Summary for ARIMA model of Time Series ID: 1064
Series: train_data
ARIMA(1,1,0)
```

```
Coefficients:
         ar1
      0.3689
s.e.  0.1400

sigma^2 = 211529:  log likelihood = -324.22
AIC=652.43   AICc=652.73   BIC=655.96

Training set error measures:
                   ME    RMSE      MAE       MPE     MAPE      MASE        ACF1
Training set 12.80561 449.348 356.5387 0.1177785 5.150877 0.3348567 -0.02848343

Forecasts for Time Series ID: 1064
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7055.048 7067.978 7072.749 7074.509
1992 7075.158 7075.397 7075.486 7075.518

Summary for ARIMA model of Time Series ID: 1065
Series: train_data
ARIMA(2,1,0)

Coefficients:
         ar1     ar2
      0.2748  0.3200
s.e.  0.1417  0.1466

sigma^2 = 63569:  log likelihood = -297.97
AIC=601.95   AICc=602.56   BIC=607.23

Training set error measures:
```

```
                      ME     RMSE      MAE       MPE     MAPE      MASE        ACF1
Training set 16.29104 243.3817 201.3774 0.2699221 2.835663 0.2740481 0.04599345


Forecasts for Time Series ID: 1065
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7812.905 7752.765 7722.288 7694.668
1992 7677.326 7663.722 7654.435 7647.529


Summary for ARIMA model of Time Series ID: 1066
Series: train_data
ARIMA(0,2,1)(0,0,1)[4]


Coefficients:
          ma1     sma1
      -0.7099  -0.5579
s.e.   0.1177   0.1273


sigma^2 = 1215:  log likelihood = -208.97
AIC=423.94   AICc=424.57   BIC=429.15


Training set error measures:
                      ME    RMSE      MAE       MPE      MAPE       MASE
Training set 4.641493 33.2353 25.10756 0.0875314 0.6644132 0.07209637
                    ACF1
Training set -0.05017086


Forecasts for Time Series ID: 1066
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6064.453 6165.792 6273.159 6376.772
1992 6478.981 6581.189 6683.398 6785.607
```

```
Summary for ARIMA model of Time Series ID: 1067
Series: train_data
ARIMA(1,1,0)(0,0,1)[4] with drift

Coefficients:
          ar1    sma1    drift
      -0.4827  0.3818  86.1558
s.e.   0.1337  0.1587  12.9110

sigma^2 = 9190:  log likelihood = -256.13
AIC=520.27   AICc=521.32   BIC=527.31

Training set error measures:
                    ME    RMSE    MAE        MPE     MAPE      MASE        ACF1
Training set 0.2717088 91.4019 66.306 0.02147527 1.429955 0.1859394 -0.02908334

Forecasts for Time Series ID: 1067
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6428.531 6547.250 6576.633 6676.281
1992 6755.924 6845.224 6929.862 7016.750

Summary for ARIMA model of Time Series ID: 1068
Series: train_data
ARIMA(0,2,1)

Coefficients:
          ma1
      -0.8739
s.e.   0.0708
```

```
sigma^2 = 15502:  log likelihood = -262.43
AIC=528.87   AICc=529.17   BIC=532.34

Training set error measures:
                   ME     RMSE     MAE       MPE     MAPE      MASE
Training set 23.76875 120.1861 80.3627 0.4155581 1.516334 0.1440902
                     ACF1
Training set -0.001827488

Forecasts for Time Series ID: 1068
          Qtr1      Qtr2      Qtr3      Qtr4
1991  9009.495  9209.989  9410.484  9610.979
1992  9811.473 10011.968 10212.462 10412.957

Summary for ARIMA model of Time Series ID: 1069
Series: train_data
ARIMA(0,1,0) with drift

Coefficients:
         drift
      102.3256
s.e.   15.5699

sigma^2 = 10673:  log likelihood = -259.93
AIC=523.86   AICc=524.16   BIC=527.38

Training set error measures:
                     ME     RMSE      MAE        MPE    MAPE      MASE
Training set 0.06135621 100.9328 73.88799 0.03715953 1.38032 0.1628206
```

```
                   ACF1
Training set 0.07773858

Forecasts for Time Series ID: 1069
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7304.326 7406.651 7508.977 7611.302
1992 7713.628 7815.953 7918.279 8020.605

Summary for ARIMA model of Time Series ID: 1070
Series: train_data
ARIMA(0,2,1)

Coefficients:
          ma1
      -0.7160
s.e.   0.0993

sigma^2 = 2346:  log likelihood = -222.41
AIC=448.83   AICc=449.14   BIC=452.3

Training set error measures:
                   ME     RMSE      MAE       MPE      MAPE       MASE
Training set 6.964559 46.75264 39.14209 0.1927596 0.7713281 0.06416735
                  ACF1
Training set -0.112275

Forecasts for Time Series ID: 1070
          Qtr1      Qtr2      Qtr3      Qtr4
1991  9055.595  9217.191  9378.786  9540.381
1992  9701.977  9863.572 10025.167 10186.763
```

```
Summary for ARIMA model of Time Series ID: 1071
Series: train_data
ARIMA(0,1,0) with drift

Coefficients:
        drift
      21.8000
s.e.  10.1913

sigma^2 = 2706:  log likelihood = -133.75
AIC=271.5   AICc=272.04   BIC=273.93

Training set error measures:
                    ME     RMSE     MAE         MPE      MAPE      MASE
Training set 0.1993537 49.97725 43.0532 0.001073569 0.7827997 0.3853419
                  ACF1
Training set 0.1577951

Forecasts for Time Series ID: 1071
       Qtr1   Qtr2   Qtr3   Qtr4
1992               5771.8 5793.6
1993 5815.4 5837.2 5859.0 5880.8
1994 5902.6 5924.4

Summary for ARIMA model of Time Series ID: 1072
Series: train_data
ARIMA(2,0,0) with non-zero mean

Coefficients:
```

```
         ar1     ar2       mean
      0.3143  0.3729  6269.8971
s.e.  0.1874  0.1966    84.7186

sigma^2 = 20725:  log likelihood = -164.8
AIC=337.6   AICc=339.51   BIC=342.64

Training set error measures:
                   ME    RMSE      MAE       MPE     MAPE      MASE        ACF1
Training set 13.35221 135.403 100.4832 0.1679609 1.585759 0.6363358 -0.07304144

Forecasts for Time Series ID: 1072
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6167.164 6184.694 6204.808 6217.667
1992 6229.209 6237.632 6244.583 6249.909

Summary for ARIMA model of Time Series ID: 1073
Series: train_data
ARIMA(0,1,0) with drift

Coefficients:
       drift
      68.560
s.e.  40.304

sigma^2 = 42304:  log likelihood = -168.12
AIC=340.24   AICc=340.79   BIC=342.68

Training set error measures:
                    ME      RMSE      MAE          MPE     MAPE      MASE
```

```
Training set 0.2404399 197.6101 144.1666 -0.03475915 2.054241 0.3670909
                    ACF1
Training set -0.08930591

Forecasts for Time Series ID: 1073
        Qtr1    Qtr2    Qtr3    Qtr4
1991 8102.56 8171.12 8239.68 8308.24
1992 8376.80 8445.36 8513.92 8582.48

Summary for ARIMA model of Time Series ID: 1074
Series: train_data
ARIMA(0,1,0)

sigma^2 = 19785:  log likelihood = -159.13
AIC=320.26   AICc=320.44   BIC=321.48

Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE       ACF1
Training set 37.85038 137.9288 113.6965 0.5539715 1.668428 0.3936613 0.08651245

Forecasts for Time Series ID: 1074
     Qtr1 Qtr2 Qtr3 Qtr4
1991 7088 7088 7088 7088
1992 7088 7088 7088 7088

Summary for ARIMA model of Time Series ID: 1075
Series: train_data
ARIMA(0,1,0) with drift

Coefficients:
```

```
        drift
      86.5600
s.e.  12.3227

sigma^2 = 3956:  log likelihood = -138.5
AIC=280.99   AICc=281.54   BIC=283.43

Training set error measures:
                    ME     RMSE      MAE        MPE      MAPE      MASE
Training set 0.2379976 60.42922 49.66877 0.01494075 0.6603715 0.1349861
                   ACF1
Training set -0.1305874

Forecasts for Time Series ID: 1075
        Qtr1    Qtr2    Qtr3    Qtr4
1991 8525.06 8611.62 8698.18 8784.74
1992 8871.30 8957.86 9044.42 9130.98

Summary for ARIMA model of Time Series ID: 1076
Series: train_data
ARIMA(0,1,0) with drift

Coefficients:
        drift
      34.2535
s.e.   6.0451

sigma^2 = 1609:  log likelihood = -219.25
AIC=442.5   AICc=442.8   BIC=446.02
```

```
Training set error measures:
                     ME     RMSE      MAE          MPE      MAPE      MASE
Training set 0.08871692 39.19161 29.66007 -0.003009321 0.6356089 0.2071704
                   ACF1
Training set -0.1234328

Forecasts for Time Series ID: 1076
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5444.953 5479.207 5513.460 5547.714
1992 5581.967 5616.221 5650.474 5684.728

Summary for ARIMA model of Time Series ID: 1077
Series: train_data
ARIMA(1,0,0)(0,1,0)[4] with drift

Coefficients:
         ar1    drift
      0.6293  56.5057
s.e.  0.1233   5.6281

sigma^2 = 3177:  log likelihood = -217.26
AIC=440.51   AICc=441.18   BIC=445.58

Training set error measures:
                   ME     RMSE      MAE         MPE     MAPE      MASE
Training set 1.237832 52.38382 39.40253 -0.01378013 0.991822 0.1757476
                   ACF1
Training set 0.01078143

Forecasts for Time Series ID: 1077
```

```
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4886.618 5165.435 5260.851 5745.194
1992 5121.974 5397.330 5490.569 5973.542

Summary for ARIMA model of Time Series ID: 1078
Series: train_data
ARIMA(1,0,0)(0,1,1)[4] with drift

Coefficients:
         ar1     sma1    drift
      0.7926  -0.3961  89.6647
s.e.  0.1009   0.1606   7.2435

sigma^2 = 4277:  log likelihood = -223.07
AIC=454.15   AICc=455.29   BIC=460.9

Training set error measures:
                    ME     RMSE      MAE         MPE      MAPE      MASE
Training set -1.193885 59.96901 44.74278 -0.01120508 0.6979053 0.1267223
                    ACF1
Training set -0.09605884

Forecasts for Time Series ID: 1078
         Qtr1     Qtr2     Qtr3     Qtr4
1991 8684.741 8212.342 8412.405 8176.081
1992 9043.338 8570.951 8771.025 8534.709

Summary for ARIMA model of Time Series ID: 1079
Series: train_data
ARIMA(0,1,1)(1,1,0)[4]
```

```
Coefficients:
          ma1     sar1
      -0.5373  -0.4280
s.e.   0.1228   0.1742

sigma^2 = 17653:  log likelihood = -245.6
AIC=497.21   AICc=497.9   BIC=502.2

Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE       ACF1
Training set 26.78473 121.8397 96.76287 0.2777864 2.443844 0.3879904 -0.1585677

Forecasts for Time Series ID: 1079
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4398.539 6167.172 6701.713 6852.954
1992 4831.652 6642.279 7237.213 7338.255

Summary for ARIMA model of Time Series ID: 1080
Series: train_data
ARIMA(1,0,0)(2,1,0)[4] with drift

Coefficients:
         ar1     sar1     sar2    drift
      0.8775  -0.3738  -0.3784  48.5984
s.e.  0.0872   0.1500   0.1402  15.5923

sigma^2 = 9262:  log likelihood = -238.53
AIC=487.05   AICc=488.81   BIC=495.49
```

```
Training set error measures:
                   ME     RMSE      MAE         MPE     MAPE      MASE
Training set 2.509564 87.05148 60.09878 -0.06274081 2.258014 0.2872894
                    ACF1
Training set -0.04497418

Forecasts for Time Series ID: 1080
         Qtr1     Qtr2     Qtr3     Qtr4
1991 3892.836 3840.710 4068.763 3971.471
1992 4171.623 4118.199 4309.794 4166.788

Summary for ARIMA model of Time Series ID: 1081
Series: train_data
ARIMA(1,0,0)(0,1,1)[4] with drift

Coefficients:
         ar1     sma1    drift
      0.8793  -0.6504  39.3259
s.e.  0.0835   0.2588  11.1832

sigma^2 = 9990:  log likelihood = -240.73
AIC=489.47   AICc=490.61   BIC=496.22

Training set error measures:
                   ME     RMSE      MAE        MPE     MAPE      MASE      ACF1
Training set 1.354891 91.65442 71.56327 -0.1470016 2.710709 0.3393449 0.1390344

Forecasts for Time Series ID: 1081
         Qtr1     Qtr2     Qtr3     Qtr4
1991 3579.665 3712.560 3763.387 3820.286
```

```
1992 3724.907 3859.256 3911.364 3969.388

Summary for ARIMA model of Time Series ID: 1082
Series: train_data
ARIMA(1,1,0)(1,1,0)[4]

Coefficients:
          ar1     sar1
      -0.4331  -0.3815
s.e.   0.1443   0.1727

sigma^2 = 2007:  log likelihood = -203
AIC=411.99   AICc=412.68   BIC=416.99

Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE
Training set 8.376976 41.08341 29.93077 0.1913548 0.862694 0.1489716
                    ACF1
Training set -0.06714039

Forecasts for Time Series ID: 1082
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4474.509 4785.268 4939.125 5166.557
1992 4793.598 5115.951 5286.908 5504.979

Summary for ARIMA model of Time Series ID: 1083
Series: train_data
ARIMA(0,1,1)(0,1,1)[4]

Coefficients:
```

```
          ma1     sma1
      -0.2909  -0.7307
s.e.   0.1801   0.1488

sigma^2 = 2655:  log likelihood = -209.62
AIC=425.24   AICc=425.92   BIC=430.23

Training set error measures:
                   ME     RMSE      MAE       MPE  MAPE      MASE        ACF1
Training set 10.75941 47.25405 36.54225 0.2890071 1.018 0.3831107 -0.02152351

Forecasts for Time Series ID: 1083
         Qtr1     Qtr2     Qtr3     Qtr4
1991 3912.191 4160.919 4286.876 4654.404
1992 4024.629 4273.357 4399.314 4766.841

Summary for ARIMA model of Time Series ID: 1084
Series: train_data
ARIMA(0,1,0)(1,1,0)[4]

Coefficients:
         sar1
      -0.2494
s.e.   0.1602

sigma^2 = 1474:  log likelihood = -197.18
AIC=398.36   AICc=398.7   BIC=401.69

Training set error measures:
                    ME     RMSE      MAE       MPE      MAPE      MASE
```

```
Training set 0.8047361 35.68096 22.38547 0.0120761 0.3864765 0.2902586
                   ACF1
Training set -0.1633188

Forecasts for Time Series ID: 1084
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6028.055 6128.038 6192.716 6293.975
1992 6126.821 6224.938 6292.789 6395.031

Summary for ARIMA model of Time Series ID: 1085
Series: train_data
ARIMA(1,1,0)(0,1,1)[4]

Coefficients:
          ar1     sma1
      -0.4365  -0.5670
s.e.   0.1443   0.1215

sigma^2 = 13416:  log likelihood = -240.5
AIC=487   AICc=487.69   BIC=491.99

Training set error measures:
                   ME    RMSE     MAE       MPE     MAPE      MASE       ACF1
Training set 24.09595 106.216 83.2412 0.5147804 2.255255 0.4890177 -0.1186638

Forecasts for Time Series ID: 1085
         Qtr1     Qtr2     Qtr3     Qtr4
1991 3587.587 4949.046 5467.439 5520.183
1992 3831.413 5198.615 5714.501 5768.339
```

```
Summary for ARIMA model of Time Series ID: 1086
Series: train_data
ARIMA(1,1,0)(0,1,1)[4]

Coefficients:
          ar1     sma1
      -0.3330  -0.6018
s.e.   0.1557   0.1507

sigma^2 = 41027:  log likelihood = -262.39
AIC=530.78   AICc=531.47   BIC=535.77

Training set error measures:
                   ME    RMSE      MAE       MPE     MAPE      MASE       ACF1
Training set 31.56133 185.741 140.7699 0.4307771 2.220954 0.3892233 0.04387432

Forecasts for Time Series ID: 1086
         Qtr1     Qtr2     Qtr3     Qtr4
1991 8617.452 8812.338 9287.481 9039.941
1992 9224.233 9401.524 9882.526 9633.034

Summary for ARIMA model of Time Series ID: 1087
Series: train_data
ARIMA(0,1,0)(1,1,0)[4]

Coefficients:
         sar1
      -0.4177
s.e.   0.1431
```

```
sigma^2 = 6914:  log likelihood = -227.62
AIC=459.24   AICc=459.57   BIC=462.57

Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE
Training set 10.68297 77.27582 57.51375 0.3924593 2.255455 0.3745824
                    ACF1
Training set -0.02213486

Forecasts for Time Series ID: 1087
         Qtr1     Qtr2     Qtr3     Qtr4
1991 3450.627 3635.799 3612.158 3837.270
1992 3714.890 3886.405 3887.729 4109.811

Summary for ARIMA model of Time Series ID: 1088
Series: train_data
ARIMA(0,1,0)(0,1,1)[4]

Coefficients:
         sma1
      -0.2904
s.e.   0.1727

sigma^2 = 3682:  log likelihood = -215.1
AIC=434.21   AICc=434.54   BIC=437.53

Training set error measures:
                   ME     RMSE      MAE       MPE      MAPE      MASE
Training set 11.32993 56.39193 44.63695 0.1752162 0.7111207 0.3059641
                   ACF1
```

```
Training set -0.1729384


Forecasts for Time Series ID: 1088
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6962.878 7426.543 7711.523 8066.145
1992 7256.743 7720.409 8005.389 8360.011


Summary for ARIMA model of Time Series ID: 1089
Series: train_data
ARIMA(0,1,0)(1,1,0)[4]


Coefficients:
         sar1
      -0.2938
s.e.   0.1490


sigma^2 = 1242:  log likelihood = -193.91
AIC=391.83   AICc=392.16   BIC=395.15


Training set error measures:
                  ME     RMSE      MAE         MPE      MAPE      MASE
Training set -3.8761 32.75408 23.66324 -0.08352343 0.4398888 0.1319849
                   ACF1
Training set 0.06447286


Forecasts for Time Series ID: 1089
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6198.969 6263.341 6216.085 6259.034
1992 6398.572 6460.484 6415.213 6460.233
```

```
Summary for ARIMA model of Time Series ID: 1090
Series: train_data
ARIMA(1,0,0)(0,1,0)[4] with drift

Coefficients:
         ar1    drift
      0.5873  61.1968
s.e.  0.1297   5.3169

sigma^2 = 3436:  log likelihood = -218.77
AIC=443.55   AICc=444.21   BIC=448.61

Training set error measures:
                    ME     RMSE      MAE         MPE      MAPE      MASE
Training set -1.544765 54.47237 39.79136 -0.03029638 0.7118339 0.1656593
                   ACF1
Training set 0.04393093

Forecasts for Time Series ID: 1090
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7270.952 6758.932 6862.483 6558.752
1992 7517.187 7004.569 7107.770 6803.832

Summary for ARIMA model of Time Series ID: 1091
Series: train_data
ARIMA(1,1,0)(0,1,1)[4]

Coefficients:
         ar1     sma1
      -0.465  -0.5185
```

```
s.e.   0.141   0.1636

sigma^2 = 1864:  log likelihood = -201.86
AIC=409.72   AICc=410.4   BIC=414.71

Training set error measures:
                    ME     RMSE      MAE        MPE      MAPE      MASE
Training set -6.512417 39.59141 27.25695 -0.1347754 0.5118123 0.1564132
                    ACF1
Training set -0.02467183

Forecasts for Time Series ID: 1091
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6076.443 6239.913 6212.316 6210.405
1992 6250.527 6412.286 6385.485 6383.204

Summary for ARIMA model of Time Series ID: 1092
Series: train_data
ARIMA(0,1,0)(0,1,1)[4]

Coefficients:
         sma1
      -0.4213
s.e.   0.1357

sigma^2 = 4825:  log likelihood = -220.6
AIC=445.21   AICc=445.54   BIC=448.54

Training set error measures:
                    ME     RMSE      MAE        MPE      MAPE      MASE
```

```
Training set -7.263373 64.55294 50.62336 -0.1479364 0.9754055 0.3715476
                   ACF1
Training set -0.0514616

Forecasts for Time Series ID: 1092
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5666.657 5488.509 5522.482 5497.280
1992 5727.438 5549.290 5583.262 5558.061

Summary for ARIMA model of Time Series ID: 1093
Series: train_data
ARIMA(1,0,0)(2,1,1)[4]

Coefficients:
         ar1     sar1     sar2     sma1
      0.9884  -0.0143  -0.3977  -0.7750
s.e.  0.0248   0.2300   0.2086   0.3428

sigma^2 = 7717:  log likelihood = -237.29
AIC=484.58   AICc=486.35   BIC=493.03

Training set error measures:
                    ME     RMSE      MAE         MPE     MAPE      MASE
Training set 0.3076179 79.46036 58.38744 0.001813533 1.151999 0.3388217
                   ACF1
Training set 0.06714897

Forecasts for Time Series ID: 1093
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5330.613 5215.966 5320.498 5154.868
```

```
1992 5338.371 5284.163 5378.066 5200.171

Summary for ARIMA model of Time Series ID: 1094
Series: train_data
ARIMA(1,1,0)(0,1,1)[4]

Coefficients:
          ar1     sma1
      -0.3694  -0.7461
s.e.   0.1555   0.1687

sigma^2 = 2907:  log likelihood = -211.49
AIC=428.98   AICc=429.67   BIC=433.97

Training set error measures:
                    ME     RMSE      MAE        MPE      MAPE      MASE
Training set -12.17763 49.44308 35.23021 -0.2355123 0.6532785 0.1811205
                   ACF1
Training set 0.02152234

Forecasts for Time Series ID: 1094
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6444.222 6419.018 6394.629 6410.063
1992 6622.824 6602.593 6576.367 6592.479

Summary for ARIMA model of Time Series ID: 1095
Series: train_data
ARIMA(2,1,0)(0,1,1)[4]

Coefficients:
```

```
         ar1     ar2     sma1
      -0.3257  0.5815  -0.6893
s.e.   0.1395  0.1716   0.2256

sigma^2 = 1382:  log likelihood = -196.05
AIC=400.1   AICc=401.28   BIC=406.75

Training set error measures:
                   ME     RMSE      MAE        MPE      MAPE     MASE
Training set 2.978576 33.62524 25.63391 0.03162078 0.7043374 0.129966
                    ACF1
Training set -0.07974485

Forecasts for Time Series ID: 1095
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4704.789 5169.176 4872.016 5378.465
1992 4991.281 5455.098 5148.708 5657.832

Summary for ARIMA model of Time Series ID: 1096
Series: train_data
ARIMA(1,0,0)(0,1,1)[4] with drift

Coefficients:
         ar1     sma1    drift
      0.4034  -0.6198  60.2491
s.e.  0.1593   0.1431   5.8045

sigma^2 = 40616:  log likelihood = -268.48
AIC=544.96   AICc=546.1   BIC=551.71
```

```
Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE
Training set -9.14858 184.8093 133.3678 -1.146181 4.180651 0.4804271
                    ACF1
Training set -0.03136299

Forecasts for Time Series ID: 1096
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4309.480 4356.940 5907.685 5288.789
1992 4470.134 4565.526 6135.607 5524.511

Summary for ARIMA model of Time Series ID: 1097
Series: train_data
ARIMA(1,0,0)(0,1,0)[4] with drift

Coefficients:
         ar1    drift
      0.8673  66.7194
s.e.  0.0747   6.2645

sigma^2 = 590.2:  log likelihood = -184.01
AIC=374.03   AICc=374.69   BIC=379.09

Training set error measures:
                     ME     RMSE      MAE          MPE      MAPE       MASE
Training set 0.03607343 22.57766 16.17088 -0.008022633 0.3854787 0.06317492
                    ACF1
Training set -0.04832301

Forecasts for Time Series ID: 1097
```

```
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5495.750 5796.655 5893.774 5899.987
1992 5792.039 6089.042 6182.777 6186.055

Summary for ARIMA model of Time Series ID: 1098
Series: train_data
ARIMA(1,0,0)(0,1,0)[4] with drift

Coefficients:
         ar1    drift
      0.5959  68.7513
s.e.  0.1312  10.3321

sigma^2 = 12522:  log likelihood = -244.65
AIC=495.31   AICc=495.98   BIC=500.38

Training set error measures:
                   ME     RMSE      MAE       MPE    MAPE      MASE       ACF1
Training set 1.383492 103.9946 80.68637 -0.044867 1.70771 0.2989381 0.01170303

Forecasts for Time Series ID: 1098
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6135.121 6221.546 6141.947 6922.794
1992 6428.711 6507.626 6423.551 7201.732

Summary for ARIMA model of Time Series ID: 1099
Series: train_data
ARIMA(1,1,0)(1,1,0)[4]

Coefficients:
```

```
          ar1     sar1
      -0.4331  -0.3815
s.e.   0.1443   0.1727

sigma^2 = 2007:  log likelihood = -203
AIC=411.99   AICc=412.68   BIC=416.99

Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE
Training set 8.376976 41.08341 29.93077 0.1913548 0.862694 0.1489716
                    ACF1
Training set -0.06714039

Forecasts for Time Series ID: 1099
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4474.509 4785.268 4939.125 5166.557
1992 4793.598 5115.951 5286.908 5504.979

Summary for ARIMA model of Time Series ID: 1100
Series: train_data
ARIMA(0,0,0)(1,1,1)[4] with drift

Coefficients:
         sar1    sma1    drift
      -0.9125  0.5815  21.2252
s.e.   0.1001  0.2224  11.3208

sigma^2 = 126710:  log likelihood = -291.57
AIC=591.13   AICc=592.27   BIC=597.89
```

```
Training set error measures:
                    ME     RMSE      MAE        MPE     MAPE      MASE
Training set -14.12461 326.4223 214.5401 -0.4320085 3.537335 0.7214464
                   ACF1
Training set 0.07352387

Forecasts for Time Series ID: 1100
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4445.256 4960.224 6504.951 8008.646
1992 4603.743 5138.358 6691.090 8250.724
```

8.36 Code computing the average Mean Absolute Percentage Error (MAPE) and Symmetric Mean Absolute Percentage Error (sMAPE) for the ARIMA models, and comparing its performance with the Theta and Damped Exponential Smoothing models, which serve as benchmarks (benchmark models fitted in Appendix 8.35)

```r
# Calculate average MAPE and sMAPE for each method
avg_mape_arima <- mean(mape_arima, na.rm = TRUE)
avg_smape_arima <- mean(smape_arima, na.rm = TRUE)
avg_mape_theta <- mean(mape_theta, na.rm = TRUE)
avg_smape_theta <- mean(smape_theta, na.rm = TRUE)
avg_mape_damped <- mean(mape_damped, na.rm = TRUE)
avg_smape_damped <- mean(smape_damped, na.rm = TRUE)

# Store evaluation metrics for each model in a data frame
arima_batch_evaluation_metrics <- data.frame(
```

```
  Model = c("ARIMA", "Theta", "Damped Exponential Smoothing"),
  MAPE = c(avg_mape_arima, avg_mape_theta, avg_mape_damped),
  sMAPE = c(avg_smape_arima, avg_smape_theta, avg_smape_damped)
)

# Print the evaluation metrics for comparison
cat("Table 19: Error measures evaluating automatic ARIMA model's
    out-of-sample accuracy")
print(arima_batch_evaluation_metrics, row.names = FALSE)

# Select the model with the lowest values for MAPE
arima_batch_best_model_mape <- arima_batch_evaluation_metrics[which.min(
    arima_batch_evaluation_metrics$MAPE), ]

# Select the model with the lowest values for sMAPE
arima_batch_best_model_smape <- arima_batch_evaluation_metrics[which.min(
    arima_batch_evaluation_metrics$sMAPE), ]

# Print the best model
cat("Best model based on MAPE:", arima_batch_best_model_mape$Model, "\n")
cat("Best model based on sMAPE:", arima_batch_best_model_smape$Model, "\n")
```

8.37 Code printing summaries of automatically fitted ETS models for each series (IDs 1001 to 1100) and printing respective forecasted values.

```
# Define the series IDs and criterion
ts_start <- 1001
```

```r
ts_end <- 1100
criterion <- "aicc"
num_ts <- ts_end - ts_start + 1

# Initialize arrays to store MAPE and sMAPE for ETS and benchmarks
mape_ets <- numeric(num_ts)
smape_ets <- numeric(num_ts)
mape_theta <- numeric(num_ts)
smape_theta <- numeric(num_ts)
mape_damped <- numeric(num_ts)
smape_damped <- numeric(num_ts)

# Loop through each time series
for (s in ts_start:ts_end) {
  train_data <- M3[[s]]$x
  test_data <- M3[[s]]$xx
  h <- length(test_data)

  # Fit ETS model
  ets_fit <- ets(train_data)
  # Print summary of the fitted ETS model
  cat("Summary for ETS model of Time Series ID:", s, "\n")
  print(summary(ets_fit))
  cat("\n")  # Add a newline after each summary
  ets_fcst <- forecast(ets_fit, h = h)$mean
  # Print forecasts
  cat("Forecasts for Time Series ID:", s, "\n")
  print(ets_fcst)
  cat("\n")  # Add a newline after printing forecasts
```

```r
# Calculate MAPE for ETS
mape_ets[s - ts_start + 1] <- 100 * mean(abs(test_data - ets_fcst) /
                                      test_data, na.rm = TRUE)
# Calculate sMAPE for ETS
smape_ets[s - ts_start + 1] <- 200 * mean(abs(test_data - ets_fcst) /
                                      (abs(test_data) + abs(ets_fcst)),
                                      na.rm = TRUE)

# Fit Theta model
theta_fit <- thetaf(train_data, h = h)
theta_fcst <- forecast(theta_fit)$mean

# Calculate MAPE for Theta
mape_theta[s - ts_start + 1] <- 100 * mean(abs(test_data - theta_fcst) /
                                           test_data, na.rm = TRUE)
# Calculate sMAPE for Theta
smape_theta[s - ts_start + 1] <- 200 * mean(abs(test_data - theta_fcst) /
                                      (abs(test_data) + abs(theta_fcst)),
                                      na.rm = TRUE)

# Fit Damped Exponential Smoothing model
tryCatch({
  damped_model <- ets(train_data, model = "ZZZ", damped = TRUE)
  damped_fcst <- forecast(damped_model, h = h)$mean
  # Calculate MAPE for Damped Exponential Smoothing
  mape_damped[s - ts_start + 1] <- 100 * mean(abs(test_data - damped_fcst) /
                                             test_data, na.rm = TRUE)
  # Calculate sMAPE for Damped Exponential Smoothing
  smape_damped[s - ts_start + 1] <- 200 * mean(abs(test_data - damped_fcst) /
                                        (abs(test_data) + abs(damped_fcst)),
```

```r
                                                       na.rm = TRUE)
  }, error = function(e) {
    mape_damped[s - ts_start + 1] <- NA  # Assign NA in case of error
    smape_damped[s - ts_start + 1] <- NA  # Assign NA in case of error
  })
}
```

```
Summary for ETS model of Time Series ID: 1001
ETS(M,A,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.9912
    beta  = 1e-04

  Initial states:
    l = 3239.3284
    b = 82.6348

  sigma:  0.0272

     AIC     AICc      BIC
600.3259 601.9049 609.2469

Training set error measures:
                   ME     RMSE      MAE         MPE     MAPE      MASE
Training set 4.126213 131.4635 101.1422 -0.05228997 2.061665 0.2424528
                  ACF1
```

```
Training set 0.1487912

Forecasts for Time Series ID: 1001
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7136.809 7219.462 7302.115 7384.768
1992 7467.421 7550.074 7632.726 7715.379

Summary for ETS model of Time Series ID: 1002
ETS(A,A,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.5518
    beta  = 0.0918

  Initial states:
    l = 4266.2976
    b = 0.4424

  sigma:  116.2911

     AIC     AICc      BIC
590.8472 592.4262 599.7682

Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE       ACF1
Training set 21.16856 110.8792 83.91645 0.4023111 1.707774 0.3220125 -0.1078922
```

```
Forecasts for Time Series ID: 1002
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6751.164 6837.080 6922.997 7008.913
1992 7094.829 7180.746 7266.662 7352.579

Summary for ETS model of Time Series ID: 1003
ETS(M,A,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.7005
    beta  = 1e-04

  Initial states:
    l = 3953.6374
    b = 54.0465

  sigma:  0.0364

     AIC     AICc      BIC
627.7882 629.3671 636.7091

Training set error measures:
                   ME     RMSE      MAE          MPE     MAPE      MASE
Training set 10.29196 171.5243 143.6277 -0.008435124 2.948394 0.4693332
                   ACF1
Training set 0.08894812
```

```
Forecasts for Time Series ID: 1003
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6701.414 6755.506 6809.598 6863.690
1992 6917.782 6971.874 7025.965 7080.057

Summary for ETS model of Time Series ID: 1004
ETS(A,A,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.282
    beta  = 1e-04

  Initial states:
    l = 3809.1182
    b = 47.8075

  sigma:  154.0684

     AIC     AICc      BIC
615.6016 617.1806 624.5226

Training set error measures:
                    ME     RMSE      MAE         MPE     MAPE      MASE
Training set -1.237137 146.8985 109.4963 -0.08473302 2.326103 0.4880873
                    ACF1
Training set -0.08249962
```

```
Forecasts for Time Series ID: 1004
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5945.904 5993.706 6041.508 6089.310
1992 6137.112 6184.914 6232.716 6280.519

Summary for ETS model of Time Series ID: 1005
ETS(M,Ad,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.9999
    beta  = 0.9999
    phi   = 0.8002

  Initial states:
    l = 4141.8157
    b = 34.3718

  sigma:  0.0113

     AIC     AICc      BIC
525.6753 527.9455 536.3804

Training set error measures:
                   ME     RMSE      MAE       MPE      MAPE     MASE      ACF1
Training set 5.850458 51.73885 43.91775 0.1324076 0.9043621 0.190667 0.3555957

Forecasts for Time Series ID: 1005
```

```
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5734.390 5701.091 5674.445 5653.123
1992 5636.060 5622.407 5611.482 5602.739

Summary for ETS model of Time Series ID: 1006
ETS(M,N,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.9999

  Initial states:
    l = 4541.1811

  sigma:  0.0229

     AIC     AICc      BIC
586.6916 587.2916 592.0442

Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE
Training set 32.71559 112.8353 95.34724 0.6011925 1.876999 0.4513212
                    ACF1
Training set -0.09516138

Forecasts for Time Series ID: 1006
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5980.494 5980.494 5980.494 5980.494
```

```
1992 5980.494 5980.494 5980.494 5980.494

Summary for ETS model of Time Series ID: 1007
ETS(A,A,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.9999
    beta  = 0.2884

  Initial states:
    l = 5288.6484
    b = -20.8917

  sigma:  115.8453

     AIC     AICc      BIC
590.5092 592.0881 599.4301

Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE
Training set 13.86633 110.4541 96.23964 0.2731804 1.727167 0.2143601
                    ACF1
Training set -0.01500038

Forecasts for Time Series ID: 1007
         Qtr1     Qtr2     Qtr3     Qtr4
1991 8604.572 8759.658 8914.744 9069.830
```

```
1992 9224.916 9380.002 9535.088 9690.174

Summary for ETS model of Time Series ID: 1008
ETS(M,N,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.9854

  Initial states:
    l = 3838.0125

  sigma:  0.0447

     AIC     AICc      BIC
643.5541 644.1541 648.9066

Training set error measures:
                   ME     RMSE     MAE      MPE     MAPE      MASE      ACF1
Training set 56.00955 220.2785 173.744 1.037716 3.443078 0.3508209 0.2479603

Forecasts for Time Series ID: 1008
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6266.451 6266.451 6266.451 6266.451
1992 6266.451 6266.451 6266.451 6266.451

Summary for ETS model of Time Series ID: 1009
ETS(M,A,N)
```

```
Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.9999
    beta  = 0.0779

  Initial states:
    l = 4269.905
    b = 15.8099

  sigma:  0.027

     AIC     AICc      BIC
602.3907 603.9696 611.3116

Training set error measures:
                  ME     RMSE      MAE       MPE     MAPE      MASE
Training set 23.81506 131.5912 109.5343 0.4084176 2.162187 0.3612907
                    ACF1
Training set 0.004897337

Forecasts for Time Series ID: 1009
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6946.894 7044.306 7141.718 7239.129
1992 7336.541 7433.953 7531.365 7628.777

Summary for ETS model of Time Series ID: 1010
ETS(A,Ad,N)
```

```
Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.9999
    beta  = 0.5172
    phi   = 0.8

  Initial states:
    l = 4026.5899
    b = 18.2219

  sigma:  167.7542

     AIC     AICc      BIC
623.9767 626.2470 634.6818

Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE
Training set 17.96498 157.9354 117.0232 0.3776026 2.473335 0.2526477
                    ACF1
Training set -0.01609635

Forecasts for Time Series ID: 1010
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6853.465 6787.826 6735.314 6693.305
1992 6659.698 6632.812 6611.303 6594.096

Summary for ETS model of Time Series ID: 1011
```

```
ETS(A,A,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 1e-04
    beta  = 1e-04

  Initial states:
    l = 5099.3612
    b = 40.3096

  sigma:  89.2441

     AIC     AICc      BIC
193.4825 199.4825 197.3455

Training set error measures:
                    ME     RMSE      MAE         MPE     MAPE      MASE
Training set 0.1964456 77.28766 61.83139 -0.01664789 1.139897 0.3796248
                   ACF1
Training set 0.00251277

Forecasts for Time Series ID: 1011
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5784.630 5824.940 5865.250 5905.560
1992 5945.870 5986.179 6026.489 6066.799

Summary for ETS model of Time Series ID: 1012
```

```
ETS(M,A,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.1964
    beta  = 0.1964

  Initial states:
    l = 4750.0529
    b = -122.5867

  sigma:  0.0602

     AIC     AICc      BIC
678.5313 680.1102 687.4522

Training set error measures:
                    ME     RMSE      MAE        MPE     MAPE      MASE
Training set -8.136966 323.5669 229.5736 -0.1765128 4.326737 0.5925819
                   ACF1
Training set -0.1359656

Forecasts for Time Series ID: 1012
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6739.687 6546.768 6353.850 6160.932
1992 5968.013 5775.095 5582.176 5389.258

Summary for ETS model of Time Series ID: 1013
```

```
ETS(A,A,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.4515
    beta  = 0.1158

  Initial states:
    l = 4805.4074
    b = -24.029

  sigma:  141.5039

     AIC     AICc      BIC
608.1155 609.6944 617.0364

Training set error measures:
                  ME     RMSE      MAE       MPE     MAPE      MASE       ACF1
Training set 24.26242 134.9186 104.2716 0.4544796 1.972449 0.3420844 0.02512423

Forecasts for Time Series ID: 1013
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7445.735 7545.362 7644.990 7744.618
1992 7844.245 7943.873 8043.500 8143.128

Summary for ETS model of Time Series ID: 1014
ETS(M,A,N)
```

```
Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.63
    beta  = 0.2017

  Initial states:
    l = 4679.1573
    b = -34.9959

  sigma:  0.0222

     AIC     AICc      BIC
588.7626 590.3416 597.6836

Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE
Training set 31.58617 109.7391 84.79316 0.5270291 1.633305 0.3097608
                     ACF1
Training set -0.007781782

Forecasts for Time Series ID: 1014
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7577.651 7823.025 8068.399 8313.774
1992 8559.148 8804.522 9049.897 9295.271

Summary for ETS model of Time Series ID: 1015
ETS(A,A,N)
```

```
Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.7013
    beta  = 0.0966

  Initial states:
    l = 4429.7437
    b = 0.4176

  sigma:  136.7076

    AIC    AICc     BIC
605.081 606.660 614.002

Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE
Training set 24.26548 130.3456 104.0812 0.4403061 2.059983 0.3419645
                    ACF1
Training set -0.02331057

Forecasts for Time Series ID: 1015
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7179.936 7283.545 7387.153 7490.762
1992 7594.371 7697.980 7801.588 7905.197

Summary for ETS model of Time Series ID: 1016
ETS(M,A,N)
```

```
Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.9999
    beta  = 0.2782

  Initial states:
    l = 4632.1274
    b = 36.9938

  sigma:  0.034

     AIC     AICc      BIC
634.6627 636.2417 643.5837

Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE       ACF1
Training set 4.966961 201.4591 147.6251 0.1613788 2.509526 0.2541318 0.02938582

Forecasts for Time Series ID: 1016
         Qtr1     Qtr2     Qtr3     Qtr4
1991 9195.325 9293.125 9390.925 9488.725
1992 9586.526 9684.326 9782.126 9879.926

Summary for ETS model of Time Series ID: 1017
ETS(A,A,N)

Call:
 ets(y = train_data)
```

```
  Smoothing parameters:
    alpha = 0.2906
    beta  = 0.2258

  Initial states:
    l = 4731.4604
    b = -135.3046

  sigma:  117.3949

     AIC     AICc      BIC
591.6785 593.2574 600.5994

Training set error measures:
                   ME     RMSE     MAE       MPE     MAPE      MASE      ACF1
Training set 16.24765 111.9316 87.2451 0.3885996 1.728419 0.3375215 0.1798649

Forecasts for Time Series ID: 1017
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6691.562 6717.701 6743.840 6769.979
1992 6796.118 6822.257 6848.396 6874.535

Summary for ETS model of Time Series ID: 1018
ETS(M,N,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
```

```
    alpha = 0.9941

  Initial states:
    l = 4183.5761

  sigma:  0.0362

     AIC     AICc      BIC
623.0375 623.6375 628.3900

Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE
Training set 22.06832 170.9744 133.0633 0.4137491 2.728301 0.4787526
                     ACF1
Training set -0.003650548

Forecasts for Time Series ID: 1018
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5148.866 5148.866 5148.866 5148.866
1992 5148.866 5148.866 5148.866 5148.866

Summary for ETS model of Time Series ID: 1019
ETS(A,N,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.8577
```

```
  Initial states:
    l = 4695.0495

  sigma:  187.6144

     AIC     AICc      BIC
631.0837 631.6837 636.4362

Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE
Training set 39.31715 183.3008 132.4284 0.6506816 2.589166 0.4872274
                    ACF1
Training set -0.05949501

Forecasts for Time Series ID: 1019
        Qtr1    Qtr2    Qtr3    Qtr4
1991 6178.83 6178.83 6178.83 6178.83
1992 6178.83 6178.83 6178.83 6178.83

Summary for ETS model of Time Series ID: 1020
ETS(A,Ad,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.9999
    beta  = 0.9999
    phi   = 0.8
```

```
  Initial states:
    l = 4435.9748
    b = 8.2928

  sigma:  70.7856

     AIC     AICc      BIC
548.0464 550.3166 558.7515

Training set error measures:
                   ME     RMSE      MAE       MPE    MAPE      MASE       ACF1
Training set 7.022565 66.64241 56.89313 0.1460096 1.14146 0.2325134 0.09503864

Forecasts for Time Series ID: 1020
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6257.191 6208.545 6169.629 6138.495
1992 6113.588 6093.663 6077.722 6064.970

Summary for ETS model of Time Series ID: 1021
ETS(A,N,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.9999

  Initial states:
    l = 4413.4281
```

```
  sigma:  172.9667

     AIC     AICc      BIC 
623.9302 624.5302 629.2828 

Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE      ACF1
Training set 55.78016 168.9899 142.6897 0.9452835 2.798246 0.3882054 0.2103819

Forecasts for Time Series ID: 1021
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6867.509 6867.509 6867.509 6867.509
1992 6867.509 6867.509 6867.509 6867.509

Summary for ETS model of Time Series ID: 1022
ETS(A,A,N) 

Call:
 ets(y = train_data) 

  Smoothing parameters:
    alpha = 0.9999 
    beta  = 1e-04 

  Initial states:
    l = 3178.462 
    b = 70.0446 

  sigma:  128.939
```

```
     AIC     AICc      BIC
599.9325 601.5115 608.8535

Training set error measures:
                    ME     RMSE      MAE        MPE     MAPE      MASE
Training set -3.486333 122.9385 99.73822 -0.1419222 2.363118 0.3203411
                  ACF1
Training set 0.1301864

Forecasts for Time Series ID: 1022
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6177.050 6247.079 6317.108 6387.138
1992 6457.167 6527.196 6597.225 6667.255

Summary for ETS model of Time Series ID: 1023
ETS(M,A,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.265
    beta  = 0.028

  Initial states:
    l = 2611.234
    b = 115.8404

  sigma:  0.0212
```

```
     AIC     AICc      BIC 
584.1612 585.7402 593.0822 

Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE      ACF1
Training set 26.51517 105.2873 85.33039 0.3533057 1.653142 0.1630076 0.1146259

Forecasts for Time Series ID: 1023
         Qtr1     Qtr2     Qtr3     Qtr4
1991 8451.449 8599.940 8748.432 8896.924
1992 9045.416 9193.908 9342.400 9490.892

Summary for ETS model of Time Series ID: 1024
ETS(M,A,N) 

Call:
 ets(y = train_data) 

  Smoothing parameters:
    alpha = 0.9999 
    beta  = 0.2995 

  Initial states:
    l = 1437.9697 
    b = 68.9562 

  sigma:  0.0331

     AIC     AICc      BIC 
569.6966 571.2756 578.6176 
```

```
Training set error measures:
                    ME     RMSE      MAE        MPE     MAPE     MASE
Training set -8.730959 103.9484 76.56922 -0.1946682 2.579851 0.233162
                   ACF1
Training set 0.03697413

Forecasts for Time Series ID: 1024
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4144.121 4098.037 4051.953 4005.869
1992 3959.785 3913.701 3867.616 3821.532

Summary for ETS model of Time Series ID: 1025
ETS(M,A,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.6768
    beta  = 0.0749

  Initial states:
    l = 2779.3415
    b = 41.9733

  sigma:  0.053

     AIC     AICc      BIC
654.2017 655.7806 663.1226
```

```
Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE
Training set 36.04055 236.9976 185.5997 0.6656223 3.966016 0.3432582
                    ACF1
Training set 0.007722159

Forecasts for Time Series ID: 1025
         Qtr1     Qtr2     Qtr3     Qtr4
1991 8261.792 8422.522 8583.252 8743.982
1992 8904.712 9065.442 9226.172 9386.902

Summary for ETS model of Time Series ID: 1026
ETS(M,A,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.9973
    beta  = 1e-04

  Initial states:
    l = 2606.4597
    b = 121.6033

  sigma:  0.0461

     AIC     AICc      BIC
652.1293 653.7082 661.0502
```

```
Training set error measures:
                   ME     RMSE      MAE         MPE    MAPE      MASE
Training set 6.816727 244.8715 180.7851 -0.06517335 3.36706 0.2946842
                    ACF1
Training set 0.002726185

Forecasts for Time Series ID: 1026
         Qtr1     Qtr2     Qtr3     Qtr4
1991 8377.945 8499.578 8621.211 8742.845
1992 8864.478 8986.111 9107.745 9229.378

Summary for ETS model of Time Series ID: 1027
ETS(M,A,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.9999
    beta  = 0.1691

  Initial states:
    l = 3037.9063
    b = 104.0715

  sigma:  0.0128

    AIC    AICc     BIC
549.233 550.812 558.154
```

```
Training set error measures:
                   ME     RMSE      MAE       MPE      MAPE       MASE
Training set 5.276471 74.91439 55.89489 0.1246731 0.9220461 0.09072557
                  ACF1
Training set 0.1218228

Forecasts for Time Series ID: 1027
          Qtr1      Qtr2      Qtr3      Qtr4
1991  9690.925  9834.245  9977.565 10120.885
1992 10264.205 10407.525 10550.845 10694.165

Summary for ETS model of Time Series ID: 1028
ETS(M,A,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.8459
    beta  = 1e-04

  Initial states:
    l = 3927.1947
    b = 34.4953

  sigma:  0.0087

     AIC     AICc      BIC
497.8685 499.4475 506.7895
```

```
Training set error measures:
                     ME     RMSE      MAE         MPE      MAPE      MASE
Training set -0.7005015 39.05971 30.41571 -0.02424047 0.6524491 0.2124484
                   ACF1
Training set 0.02509888

Forecasts for Time Series ID: 1028
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5453.210 5487.702 5522.194 5556.686
1992 5591.179 5625.671 5660.163 5694.656

Summary for ETS model of Time Series ID: 1029
ETS(A,A,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.3941
    beta  = 3e-04

  Initial states:
    l = 5408.3955
    b = 58.2576

  sigma:  120.7161

     AIC     AICc      BIC
594.1335 595.7125 603.0545
```

```
Training set error measures:
                     ME     RMSE      MAE         MPE    MAPE      MASE
Training set -0.1399029 115.0983 92.35358 -0.05504651 1.42598 0.3512712
                     ACF1
Training set -0.007251207

Forecasts for Time Series ID: 1029
         Qtr1     Qtr2     Qtr3     Qtr4
1991 8024.735 8082.991 8141.246 8199.502
1992 8257.757 8316.013 8374.268 8432.523

Summary for ETS model of Time Series ID: 1030
ETS(M,N,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.9999

  Initial states:
    l = 3200.3074

  sigma:  0.0323

     AIC     AICc      BIC
593.4200 594.0200 598.7726

Training set error measures:
```

```
                    ME     RMSE      MAE       MPE     MAPE      MASE      ACF1
Training set 21.20451 122.7163 99.17852 0.5320504 2.576993 0.3421129 0.2360295

Forecasts for Time Series ID: 1030
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4133.212 4133.212 4133.212 4133.212
1992 4133.212 4133.212 4133.212 4133.212

Summary for ETS model of Time Series ID: 1031
ETS(A,A,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.7482
    beta  = 1e-04

  Initial states:
    l = 4536.546
    b = 81.9705

  sigma:  242.7631

     AIC     AICc      BIC
655.6143 657.1932 664.5352

Training set error measures:
                     ME     RMSE      MAE        MPE     MAPE      MASE
Training set -0.9796895 231.4655 189.9726 -0.2981587 3.444144 0.4170411
```

```
                    ACF1
Training set 0.005581536

Forecasts for Time Series ID: 1031
         Qtr1     Qtr2     Qtr3     Qtr4
1991 8190.000 8271.967 8353.933 8435.899
1992 8517.865 8599.831 8681.798 8763.764

Summary for ETS model of Time Series ID: 1032
ETS(M,N,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.9999

  Initial states:
    l = 4796.5196

  sigma:  0.0445

     AIC     AICc      BIC
663.1561 663.7561 668.5086

Training set error measures:
                  ME     RMSE      MAE      MPE    MAPE      MASE      ACF1
Training set 69.7008 275.4024 216.9731 1.032664 3.42148 0.3488524 0.2285864

Forecasts for Time Series ID: 1032
```

```
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7863.047 7863.047 7863.047 7863.047
1992 7863.047 7863.047 7863.047 7863.047

Summary for ETS model of Time Series ID: 1033
ETS(A,A,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.998
    beta  = 1e-04

  Initial states:
    l = 6622.1422
    b = 58.499

  sigma:  85.8906

     AIC     AICc      BIC
564.1813 565.7602 573.1022

Training set error measures:
                   ME     RMSE      MAE          MPE     MAPE      MASE
Training set 0.882954 81.89349 68.20942 -0.005010301 0.882314 0.2450931
                  ACF1
Training set 0.1209959

Forecasts for Time Series ID: 1033
```

```
         Qtr1     Qtr2     Qtr3     Qtr4
1991 9293.083 9351.586 9410.089 9468.592
1992 9527.095 9585.598 9644.101 9702.603

Summary for ETS model of Time Series ID: 1034
ETS(A,A,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.7705
    beta  = 1e-04

  Initial states:
    l = 2462.6707
    b = 63.451

  sigma:  41.0786

     AIC     AICc      BIC
499.2736 500.8526 508.1946

Training set error measures:
                     ME     RMSE      MAE         MPE      MAPE      MASE
Training set -0.1004707 39.16693 32.86079 0.02544259 0.8770825 0.1295326
                    ACF1
Training set -0.03555657

Forecasts for Time Series ID: 1034
```

```
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5314.868 5378.319 5441.769 5505.220
1992 5568.670 5632.121 5695.571 5759.022

Summary for ETS model of Time Series ID: 1035
ETS(M,A,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.9338
    beta  = 0.5512

  Initial states:
    l = 2255.5435
    b = 54.6724

  sigma:  0.0093

     AIC     AICc      BIC
481.5433 483.1223 490.4643

Training set error measures:
                    ME     RMSE      MAE         MPE      MAPE       MASE
Training set -1.407889 34.09857 25.07492 -0.01402281 0.6687911 0.09460003
                    ACF1
Training set -0.02354118

Forecasts for Time Series ID: 1035
```

```
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5086.538 5107.067 5127.597 5148.126
1992 5168.655 5189.184 5209.713 5230.243

Summary for ETS model of Time Series ID: 1036
ETS(M,A,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.9999
    beta  = 5e-04

  Initial states:
    l = 3018.6132
    b = 45.9072

  sigma:  0.0238

     AIC     AICc      BIC
572.0967 573.6756 581.0176

Training set error measures:
                     ME    RMSE      MAE         MPE     MAPE      MASE
Training set -0.9207865 92.0135 70.91509 -0.06442032 1.747482 0.3418213
                   ACF1
Training set 0.04487423

Forecasts for Time Series ID: 1036
```

```
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5042.887 5088.775 5134.663 5180.551
1992 5226.440 5272.328 5318.216 5364.104

Summary for ETS model of Time Series ID: 1037
ETS(M,A,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.9999
    beta  = 3e-04

  Initial states:
    l = 2899.2956
    b = 57.5828

  sigma:  0.0326

     AIC     AICc      BIC
603.5659 605.1448 612.4868

Training set error measures:
                    ME     RMSE      MAE        MPE     MAPE      MASE
Training set -4.160498 138.1855 97.99897 -0.1292752 2.216211 0.3537869
                   ACF1
Training set 0.04805104

Forecasts for Time Series ID: 1037
```

```
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5307.512 5365.048 5422.584 5480.120
1992 5537.656 5595.192 5652.728 5710.264

Summary for ETS model of Time Series ID: 1038
ETS(M,A,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.9999
    beta  = 0.1018

  Initial states:
    l = 1550.7188
    b = 72.0316

  sigma:  0.0146

     AIC     AICc      BIC
502.6509 504.2299 511.5719

Training set error measures:
                   ME     RMSE      MAE        MPE     MAPE      MASE    ACF1
Training set 3.442395 41.71861 31.40408 0.04338443 1.049344 0.1023451 0.25206

Forecasts for Time Series ID: 1038
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4933.154 5020.601 5108.049 5195.497
```

```
1992 5282.945 5370.393 5457.841 5545.288

Summary for ETS model of Time Series ID: 1039
ETS(A,A,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.9008
    beta  = 0.2789

  Initial states:
    l = 2287.7009
    b = 81.554

  sigma:  115.7322

     AIC     AICc      BIC
590.4233 592.0022 599.3442

Training set error measures:
                    ME     RMSE      MAE        MPE     MAPE      MASE
Training set -1.877698 110.3464 89.27653 0.01558501 2.141512 0.1898652
                    ACF1
Training set -0.02578994

Forecasts for Time Series ID: 1039
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7238.154 7296.663 7355.172 7413.681
```

```
1992 7472.190 7530.699 7589.208 7647.717

Summary for ETS model of Time Series ID: 1040
ETS(M,A,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.7193
    beta  = 1e-04

  Initial states:
    l = 1651.5676
    b = 79.6336

  sigma:  0.0401

     AIC     AICc      BIC
602.0929 603.6719 611.0139

Training set error measures:
                   ME     RMSE      MAE        MPE     MAPE      MASE
Training set 13.12781 137.5924 104.5709 0.08578214 2.955385 0.2682422
                   ACF1
Training set 0.01233195

Forecasts for Time Series ID: 1040
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5651.116 5730.808 5810.499 5890.190
```

```
1992 5969.882 6049.573 6129.264 6208.956

Summary for ETS model of Time Series ID: 1041
ETS(M,A,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.9999
    beta  = 0.1691

  Initial states:
    l = 3037.9063
    b = 104.0715

  sigma:  0.0128

    AIC    AICc     BIC
549.233 550.812 558.154

Training set error measures:
                   ME     RMSE      MAE       MPE      MAPE       MASE
Training set 5.276471 74.91439 55.89489 0.1246731 0.9220461 0.09072557
                  ACF1
Training set 0.1218228

Forecasts for Time Series ID: 1041
          Qtr1      Qtr2      Qtr3      Qtr4
1991  9690.925  9834.245  9977.565 10120.885
```

```
1992 10264.205 10407.525 10550.845 10694.165

Summary for ETS model of Time Series ID: 1042
ETS(A,N,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.8893

  Initial states:
    l = 3569.378

  sigma:  462.812

     AIC     AICc      BIC
710.5417 711.1417 715.8943

Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE
Training set 53.91049 452.1712 259.4539 0.5951371 5.520216 0.3952078
                    ACF1
Training set -0.02634482

Forecasts for Time Series ID: 1042
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5678.816 5678.816 5678.816 5678.816
1992 5678.816 5678.816 5678.816 5678.816
```

```
Summary for ETS model of Time Series ID: 1043
ETS(M,A,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.9999
    beta  = 0.1627

  Initial states:
    l = 2841.793
    b = 109.1369

  sigma:  0.0119

     AIC     AICc      BIC
539.3723 540.9513 548.2933

Training set error measures:
                   ME     RMSE    MAE       MPE      MAPE       MASE      ACF1
Training set 5.754248 68.12513 53.857 0.1200653 0.9152801 0.08940888 0.1230461

Forecasts for Time Series ID: 1043
          Qtr1      Qtr2      Qtr3      Qtr4
1991  9415.243  9565.581  9715.919  9866.257
1992 10016.595 10166.933 10317.272 10467.610

Summary for ETS model of Time Series ID: 1044
ETS(M,A,N)
```

```
Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.9999
    beta  = 0.1691

  Initial states:
    l = 3037.9063
    b = 104.0715

  sigma:  0.0128

    AIC    AICc     BIC
549.233 550.812 558.154

Training set error measures:
                   ME     RMSE      MAE       MPE      MAPE       MASE
Training set 5.276471 74.91439 55.89489 0.1246731 0.9220461 0.09072557
                  ACF1
Training set 0.1218228

Forecasts for Time Series ID: 1044
          Qtr1      Qtr2      Qtr3      Qtr4
1991  9690.925  9834.245  9977.565 10120.885
1992 10264.205 10407.525 10550.845 10694.165

Summary for ETS model of Time Series ID: 1045
ETS(A,N,N)
```

```
Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.9406

  Initial states:
    l = 5304.1437

  sigma:  520.2362

     AIC     AICc      BIC
720.8344 721.4344 726.1869

Training set error measures:
                  ME     RMSE      MAE       MPE     MAPE      MASE
Training set 48.4998 508.2752 275.9132 0.3287836 4.778733 0.3926472
                     ACF1
Training set -0.003785845

Forecasts for Time Series ID: 1045
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7311.431 7311.431 7311.431 7311.431
1992 7311.431 7311.431 7311.431 7311.431

Summary for ETS model of Time Series ID: 1046
ETS(M,A,N)

Call:
```

```
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.9879
    beta  = 1e-04

  Initial states:
    l = 6290.3001
    b = 57.0976

  sigma:  0.0105

     AIC     AICc      BIC
556.9769 558.5558 565.8978

Training set error measures:
                   ME     RMSE      MAE         MPE      MAPE      MASE
Training set 1.526496 75.36663 63.30666 0.009103625 0.8394594 0.2465213
                  ACF1
Training set 0.1976588

Forecasts for Time Series ID: 1046
         Qtr1     Qtr2     Qtr3     Qtr4
1991 8926.027 8983.131 9040.235 9097.340
1992 9154.444 9211.548 9268.653 9325.757

Summary for ETS model of Time Series ID: 1047
ETS(A,A,N)

Call:
```

```
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.998
    beta  = 1e-04

  Initial states:
    l = 6622.1422
    b = 58.499

  sigma:  85.8906

     AIC     AICc      BIC
564.1813 565.7602 573.1022

Training set error measures:
                   ME     RMSE      MAE          MPE     MAPE      MASE
Training set 0.882954 81.89349 68.20942 -0.005010301 0.882314 0.2450931
                  ACF1
Training set 0.1209959

Forecasts for Time Series ID: 1047
         Qtr1     Qtr2     Qtr3     Qtr4
1991 9293.083 9351.586 9410.089 9468.592
1992 9527.095 9585.598 9644.101 9702.603

Summary for ETS model of Time Series ID: 1048
ETS(M,A,N)

Call:
```

```
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.9999
    beta  = 0.9999

  Initial states:
    l = 2250.3933
    b = 69.8385

  sigma:  0.0053

     AIC     AICc      BIC
449.2109 450.7898 458.1318

Training set error measures:
                     ME     RMSE     MAE        MPE      MAPE       MASE
Training set 0.09449977 22.93464 18.5772 0.02890167 0.4111384 0.03971716
                  ACF1
Training set 0.1153727

Forecasts for Time Series ID: 1048
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7322.494 7396.490 7470.486 7544.482
1992 7618.478 7692.474 7766.471 7840.467

Summary for ETS model of Time Series ID: 1049
ETS(M,A,A)

Call:
```

```
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.9995
    beta  = 1e-04
    gamma = 1e-04

  Initial states:
    l = 1406.2569
    b = 46.302
    s = 523.9656 -13.3425 -338.0059 -172.6173

  sigma:  0.07

     AIC     AICc      BIC
620.4997 625.7939 636.5574

Training set error measures:
                     ME    RMSE      MAE        MPE     MAPE      MASE     ACF1
Training set -0.4644707 149.053 116.3146 -0.2795175 5.084622 0.3688371 0.190879

Forecasts for Time Series ID: 1049
         Qtr1     Qtr2     Qtr3     Qtr4
1991 3296.706 3177.612 3548.592 4132.129
1992 3481.905 3362.812 3733.792 4317.328

Summary for ETS model of Time Series ID: 1050
ETS(M,A,N)

Call:
```

```
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.6041
    beta  = 2e-04

  Initial states:
    l = 1791.9554
    b = 56.9899

  sigma:  0.054

     AIC     AICc      BIC
619.7744 621.3534 628.6954

Training set error measures:
                    ME    RMSE      MAE        MPE     MAPE      MASE      ACF1
Training set -5.665167 171.127 119.5778 -0.3637929 3.842223 0.3806999 0.1242307

Forecasts for Time Series ID: 1050
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4206.359 4263.301 4320.242 4377.183
1992 4434.125 4491.066 4548.007 4604.949

Summary for ETS model of Time Series ID: 1051
ETS(M,A,N)

Call:
 ets(y = train_data)
```

```
  Smoothing parameters:
    alpha = 0.9983
    beta  = 0.2757

  Initial states:
    l = 1251.9933
    b = 83.2152

  sigma:  0.0379

     AIC     AICc      BIC
571.5327 573.1116 580.4536

Training set error measures:
                    ME     RMSE      MAE        MPE     MAPE      MASE
Training set -9.896517 105.7415 75.81354 -0.3143305 2.898451 0.2407505
                   ACF1
Training set 0.01332194

Forecasts for Time Series ID: 1051
         Qtr1     Qtr2     Qtr3     Qtr4
1991 3751.008 3714.165 3677.322 3640.479
1992 3603.636 3566.793 3529.950 3493.107

Summary for ETS model of Time Series ID: 1052
ETS(M,A,N)

Call:
 ets(y = train_data)
```

```
  Smoothing parameters:
    alpha = 0.9999
    beta  = 0.2995

  Initial states:
    l = 1437.9697
    b = 68.9562

  sigma:  0.0331

     AIC     AICc      BIC
569.6966 571.2756 578.6176

Training set error measures:
                    ME     RMSE      MAE        MPE     MAPE     MASE
Training set -8.730959 103.9484 76.56922 -0.1946682 2.579851 0.233162
                   ACF1
Training set 0.03697413

Forecasts for Time Series ID: 1052
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4144.121 4098.037 4051.953 4005.869
1992 3959.785 3913.701 3867.616 3821.532

Summary for ETS model of Time Series ID: 1053
ETS(M,Ad,N)

Call:
 ets(y = train_data)
```

```
  Smoothing parameters:
    alpha = 0.8086
    beta  = 0.8086
    phi   = 0.8025

  Initial states:
    l = 1493.4165
    b = 159.9101

  sigma:  0.0454

     AIC     AICc      BIC
597.1514 599.4217 607.8565

Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE
Training set 11.54429 121.9716 92.84828 0.4986724 3.330173 0.2234481
                    ACF1
Training set -0.02377087

Forecasts for Time Series ID: 1053
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4326.897 4306.399 4289.949 4276.748
1992 4266.153 4257.651 4250.827 4245.351

Summary for ETS model of Time Series ID: 1054
ETS(M,A,N)

Call:
 ets(y = train_data)
```

```
  Smoothing parameters:
    alpha = 0.9982
    beta  = 0.1757

  Initial states:
    l = 1569.5861
    b = 165.697

  sigma:  0.0628

     AIC     AICc      BIC
658.3826 659.9615 667.3035

Training set error measures:
                    ME     RMSE      MAE        MPE     MAPE      MASE
Training set -18.20897 305.8269 219.4368 -0.3764088 4.795713 0.2740563
                  ACF1
Training set 0.2422269

Forecasts for Time Series ID: 1054
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7670.963 7695.865 7720.768 7745.670
1992 7770.573 7795.476 7820.378 7845.281

Summary for ETS model of Time Series ID: 1055
ETS(M,A,N)

Call:
 ets(y = train_data)
```

```
  Smoothing parameters:
    alpha = 0.9375
    beta  = 1e-04

  Initial states:
    l = 2236.1873
    b = 112.0693

  sigma:  0.055

     AIC     AICc      BIC
657.0869 658.6659 666.0079

Training set error measures:
                    ME     RMSE      MAE        MPE     MAPE      MASE
Training set -15.82483 272.7893 209.9632 -0.4131218 4.300731 0.3493564
                   ACF1
Training set 0.07902627

Forecasts for Time Series ID: 1055
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6626.417 6738.417 6850.416 6962.416
1992 7074.416 7186.415 7298.415 7410.415

Summary for ETS model of Time Series ID: 1056
ETS(M,Ad,N)

Call:
 ets(y = train_data)
```

```
  Smoothing parameters:
    alpha = 0.9999
    beta  = 0.6734
    phi   = 0.8

  Initial states:
    l = 1849.7988
    b = 31.6942

  sigma:  0.0743

     AIC     AICc      BIC
662.3445 664.6148 673.0496

Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE       ACF1
Training set 21.23359 411.8406 268.3326 0.8617495 5.675488 0.2535925 0.02967799

Forecasts for Time Series ID: 1056
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5881.488 5790.693 5718.056 5659.947
1992 5613.460 5576.270 5546.518 5522.716

Summary for ETS model of Time Series ID: 1057
ETS(M,A,N)

Call:
 ets(y = train_data)
```

```
  Smoothing parameters:
    alpha = 0.8378
    beta  = 0.6395

  Initial states:
    l = 2391.8995
    b = 201.013

  sigma:  0.0382

     AIC     AICc      BIC
634.3147 635.8937 643.2357

Training set error measures:
                    ME     RMSE      MAE        MPE     MAPE      MASE
Training set -10.69232 200.4079 155.0354 -0.1127814 2.928059 0.2099044
                   ACF1
Training set 0.05377627

Forecasts for Time Series ID: 1057
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7825.878 7726.020 7626.161 7526.303
1992 7426.444 7326.585 7226.727 7126.868

Summary for ETS model of Time Series ID: 1058
ETS(M,N,N)

Call:
 ets(y = train_data)
```

```
  Smoothing parameters:
    alpha = 0.6119

  Initial states:
    l = 3739.3074

  sigma:  0.0531

     AIC     AICc      BIC
639.8638 640.4638 645.2164

Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE       ACF1
Training set 11.72587 205.5779 156.8057 0.1032196 4.035893 0.5697883 0.05085248

Forecasts for Time Series ID: 1058
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4055.012 4055.012 4055.012 4055.012
1992 4055.012 4055.012 4055.012 4055.012

Summary for ETS model of Time Series ID: 1059
ETS(M,N,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.9999

  Initial states:
```

```
    l = 2830.8656

  sigma:  0.0365

     AIC     AICc      BIC
594.5527 595.1527 599.9053

Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE      ACF1
Training set 20.63714 124.4355 99.2383 0.5692944 2.871767 0.3344623 0.2044762

Forecasts for Time Series ID: 1059
         Qtr1     Qtr2     Qtr3     Qtr4
1991 3738.809 3738.809 3738.809 3738.809
1992 3738.809 3738.809 3738.809 3738.809

Summary for ETS model of Time Series ID: 1060
ETS(M,N,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.9999

  Initial states:
    l = 3200.3074

  sigma:  0.0323
```

```
     AIC     AICc      BIC
593.4200 594.0200 598.7726

Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE      ACF1
Training set 21.20451 122.7163 99.17852 0.5320504 2.576993 0.3421129 0.2360295

Forecasts for Time Series ID: 1060
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4133.212 4133.212 4133.212 4133.212
1992 4133.212 4133.212 4133.212 4133.212

Summary for ETS model of Time Series ID: 1061
ETS(A,N,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.9999

  Initial states:
    l = 4100.6341

  sigma:  200.7743

     AIC     AICc      BIC
637.0494 637.6494 642.4020

Training set error measures:
```

```
                   ME     RMSE      MAE         MPE     MAPE      MASE
Training set 2.531426 196.1582 160.1289 -0.05239835 3.871802 0.3362993
                  ACF1
Training set 0.4267028

Forecasts for Time Series ID: 1061
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4212.006 4212.006 4212.006 4212.006
1992 4212.006 4212.006 4212.006 4212.006

Summary for ETS model of Time Series ID: 1062
ETS(M,N,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.9999

  Initial states:
    l = 3745.8634

  sigma:  0.0635

     AIC     AICc      BIC
685.4280 686.0280 690.7806

Training set error measures:
                   ME     RMSE      MAE      MPE     MAPE      MASE      ACF1
Training set 84.05707 354.1612 267.8752 1.378923 4.584946 0.3493417 0.2671659
```

```
Forecasts for Time Series ID: 1062
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7444.004 7444.004 7444.004 7444.004
1992 7444.004 7444.004 7444.004 7444.004

Summary for ETS model of Time Series ID: 1063
ETS(M,N,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.9807

  Initial states:
    l = 4291.9845

  sigma:  0.0603

     AIC     AICc      BIC
682.7168 683.3168 688.0693

Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE       ACF1
Training set 48.38261 335.9753 254.9718 0.7526733 4.393948 0.3799454 0.02556142

Forecasts for Time Series ID: 1063
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6379.717 6379.717 6379.717 6379.717
```

```
1992 6379.717 6379.717 6379.717 6379.717

Summary for ETS model of Time Series ID: 1064
ETS(M,N,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.9999

  Initial states:
    l = 6125.4804

  sigma:  0.0699

     AIC     AICc      BIC
710.6544 711.2544 716.0070

Training set error measures:
                   ME     RMSE      MAE        MPE     MAPE      MASE      ACF1
Training set 20.33181 484.8095 373.0713 0.07654764 5.452458 0.3503839 0.3732546

Forecasts for Time Series ID: 1064
        Qtr1    Qtr2    Qtr3    Qtr4
1991 7019.99 7019.99 7019.99 7019.99
1992 7019.99 7019.99 7019.99 7019.99

Summary for ETS model of Time Series ID: 1065
ETS(M,N,N)
```

```
Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.9999

  Initial states:
    l = 5697.9276

  sigma:  0.0413

     AIC     AICc      BIC
668.4277 669.0277 673.7803

Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE      ACF1
Training set 49.06372 281.4081 236.8665 0.6502471 3.366511 0.3223441 0.3835562

Forecasts for Time Series ID: 1065
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7856.515 7856.515 7856.515 7856.515
1992 7856.515 7856.515 7856.515 7856.515

Summary for ETS model of Time Series ID: 1066
ETS(M,A,N)

Call:
 ets(y = train_data)
```

```
  Smoothing parameters:
    alpha = 0.8925
    beta  = 0.0727

  Initial states:
    l = 2161.8899
    b = 75.2331

  sigma:  0.0104

     AIC     AICc      BIC
495.7267 497.3056 504.6476

Training set error measures:
                   ME     RMSE      MAE       MPE      MAPE       MASE
Training set 6.984251 38.75817 29.54347 0.1353523 0.7602039 0.08483409
                  ACF1
Training set 0.1367202

Forecasts for Time Series ID: 1066
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6058.147 6155.715 6253.284 6350.853
1992 6448.421 6545.990 6643.558 6741.127

Summary for ETS model of Time Series ID: 1067
ETS(M,A,N)

Call:
 ets(y = train_data)
```

```
  Smoothing parameters:
    alpha = 0.4238
    beta  = 0.1358

  Initial states:
    l = 2519.6694
    b = 82.4839

  sigma:  0.0217

    AIC    AICc     BIC
574.052 575.631 582.973

Training set error measures:
                    ME     RMSE      MAE       MPE     MAPE      MASE
Training set -8.671643 99.14112 72.27221 -0.122814 1.546111 0.2026702
                    ACF1
Training set -0.09818945

Forecasts for Time Series ID: 1067
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6390.262 6420.939 6451.616 6482.293
1992 6512.971 6543.648 6574.325 6605.002

Summary for ETS model of Time Series ID: 1068
ETS(M,A,N)

Call:
 ets(y = train_data)
```

```
  Smoothing parameters:
    alpha = 0.9999
    beta  = 0.0688

  Initial states:
    l = 2781.1327
    b = 101.5022

  sigma:  0.0226

     AIC     AICc      BIC
588.0627 589.6417 596.9837

Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE       ACF1
Training set 24.43454 120.6678 79.29798 0.3098768 1.525428 0.1421812 0.04807232

Forecasts for Time Series ID: 1068
          Qtr1      Qtr2      Qtr3      Qtr4
1991  8984.473  9159.943  9335.413  9510.883
1992  9686.352  9861.822 10037.292 10212.761

Summary for ETS model of Time Series ID: 1069
ETS(M,A,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.9217
```

```
    beta  = 1e-04

  Initial states:
    l = 2705.4725
    b = 106.5455

  sigma:  0.0188

     AIC     AICc      BIC
571.7109 573.2898 580.6318

Training set error measures:
                    ME     RMSE      MAE         MPE     MAPE      MASE     ACF1
Training set -4.281421 101.961 74.88988 -0.05711421 1.390997 0.1650284 0.150749

Forecasts for Time Series ID: 1069
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7326.779 7433.305 7539.832 7646.359
1992 7752.885 7859.412 7965.939 8072.465

Summary for ETS model of Time Series ID: 1070
ETS(M,A,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.8067
    beta  = 0.2752
```

```
  Initial states:
    l = 2378.8352
    b = 87.9501

  sigma:  0.0094

     AIC     AICc      BIC
508.6376 510.2165 517.5585

Training set error measures:
                   ME     RMSE      MAE       MPE      MAPE       MASE
Training set 5.309458 46.53471 38.56272 0.1513055 0.7743448 0.06321758
                  ACF1
Training set 0.0793359

Forecasts for Time Series ID: 1070
          Qtr1      Qtr2      Qtr3      Qtr4
1991  9045.565  9197.797  9350.030  9502.263
1992  9654.495  9806.728  9958.960 10111.193

Summary for ETS model of Time Series ID: 1071
ETS(A,A,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.9995
    beta  = 1e-04
```

```
  Initial states:
    l = 5265.9828
    b = 18.2886

  sigma:  57.0185

     AIC     AICc      BIC
300.6226 303.6226 306.9131

Training set error measures:
                    ME     RMSE      MAE          MPE     MAPE    MASE
Training set 0.3298402 52.44939 46.04505 4.993715e-05 0.839871 0.41212
                  ACF1
Training set 0.1573392

Forecasts for Time Series ID: 1071
         Qtr1     Qtr2     Qtr3     Qtr4
1992                   5768.300 5786.590
1993 5804.879 5823.168 5841.458 5859.747
1994 5878.037 5896.326

Summary for ETS model of Time Series ID: 1072
ETS(M,N,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.5254
```

```
  Initial states:
    l = 6089.626

  sigma:  0.0233

     AIC     AICc      BIC
348.1648 349.2557 351.9391

Training set error measures:
                   ME     RMSE     MAE        MPE     MAPE    MASE       ACF1
Training set 4.311375 142.1273 111.378 0.03359157 1.757642 0.70533 -0.1463669

Forecasts for Time Series ID: 1072
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6148.525 6148.525 6148.525 6148.525
1992 6148.525 6148.525 6148.525 6148.525

Summary for ETS model of Time Series ID: 1073
ETS(A,N,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.9999

  Initial states:
    l = 6320.1367

  sigma:  217.2531
```

```
     AIC     AICc      BIC 
368.4447 369.5356 372.2190 

Training set error measures:
                   ME   RMSE      MAE       MPE     MAPE     MASE        ACF1
Training set 65.92571 208.73 167.2402 0.8785088 2.353786 0.425843 -0.09839429

Forecasts for Time Series ID: 1073
         Qtr1     Qtr2     Qtr3     Qtr4
1991 8034.031 8034.031 8034.031 8034.031
1992 8034.031 8034.031 8034.031 8034.031

Summary for ETS model of Time Series ID: 1074
ETS(A,N,N) 

Call:
 ets(y = train_data) 

  Smoothing parameters:
    alpha = 0.9999 

  Initial states:
    l = 6110.2862 

  sigma:  143.5578

     AIC     AICc      BIC 
346.8998 347.9907 350.6741 
```

```
Training set error measures:
                   ME     RMSE     MAE       MPE     MAPE      MASE       ACF1
Training set 37.60861 137.9259 113.474 0.5500061 1.664781 0.3928909 0.08490943

Forecasts for Time Series ID: 1074
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7088.012 7088.012 7088.012 7088.012
1992 7088.012 7088.012 7088.012 7088.012

Summary for ETS model of Time Series ID: 1075
ETS(M,A,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.5197
    beta  = 0.4293

  Initial states:
    l = 6146.1166
    b = 101.717

  sigma:  0.0083

     AIC     AICc      BIC
304.9908 307.9908 311.2813

Training set error measures:
                    ME     RMSE       MAE         MPE       MAPE       MASE
```

```
Training set -10.55288 58.04296 48.32071 -0.1270145 0.6485127 0.1313225
                    ACF1
Training set -0.05655147

Forecasts for Time Series ID: 1075
         Qtr1     Qtr2     Qtr3     Qtr4
1991 8421.612 8405.533 8389.455 8373.376
1992 8357.297 8341.218 8325.140 8309.061

Summary for ETS model of Time Series ID: 1076
ETS(M,A,N)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.8459
    beta  = 1e-04

  Initial states:
    l = 3927.1947
    b = 34.4953

  sigma:  0.0087

     AIC     AICc      BIC
497.8685 499.4475 506.7895

Training set error measures:
                     ME     RMSE       MAE         MPE       MAPE       MASE
```

```
Training set -0.7005015 39.05971 30.41571 -0.02424047 0.6524491 0.2124484
                   ACF1
Training set 0.02509888

Forecasts for Time Series ID: 1076
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5453.210 5487.702 5522.194 5556.686
1992 5591.179 5625.671 5660.163 5694.656

Summary for ETS model of Time Series ID: 1077
ETS(M,A,M)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.6214
    beta  = 5e-04
    gamma = 1e-04

  Initial states:
    l = 2631.8311
    b = 58.0655
    s = 1.0871 0.9996 0.9853 0.928

  sigma:  0.0129

     AIC     AICc      BIC
517.6076 522.9018 533.6654
```

```
Training set error measures:
                    ME     RMSE      MAE        MPE     MAPE      MASE
Training set -4.311584 46.48302 34.86389 -0.1405482 0.900051 0.1555039
                  ACF1
Training set 0.1038392

Forecasts for Time Series ID: 1077
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4757.536 5108.655 5240.496 5762.220
1992 4972.722 5337.139 5472.284 6014.297

Summary for ETS model of Time Series ID: 1078
ETS(M,A,M)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.9589
    beta  = 0.0462
    gamma = 8e-04

  Initial states:
    l = 4286.4055
    b = 107.2432
    s = 0.9551 0.9958 0.9852 1.0638

  sigma:  0.0094

     AIC     AICc      BIC
```

```
533.0512 538.3453 549.1089

Training set error measures:
                    ME     RMSE      MAE        MPE     MAPE      MASE
Training set -8.050128 53.08004 41.25156 -0.1451886 0.658414 0.1168343
                    ACF1
Training set -0.01014735

Forecasts for Time Series ID: 1078
         Qtr1     Qtr2     Qtr3     Qtr4
1991 8803.743 8243.457 8422.997 8165.682
1992 9192.006 8603.046 8786.454 8514.276

Summary for ETS model of Time Series ID: 1079
ETS(M,A,M)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.4568
    beta  = 0.1038
    gamma = 1e-04

  Initial states:
    l = 3191.084
    b = 34.5096
    s = 1.1198 1.1536 1.029 0.6976

  sigma:  0.0298
```

```
     AIC     AICc      BIC
592.9109 598.2051 608.9686

Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE
Training set 15.14118 112.7096 80.70632 0.3100376 2.032878 0.3236084
                    ACF1
Training set -0.03054436

Forecasts for Time Series ID: 1079
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4020.025 6039.998 6894.014 6811.804
1992 4317.744 6479.183 7386.348 7289.733

Summary for ETS model of Time Series ID: 1080
ETS(M,A,A)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.8932
    beta  = 3e-04
    gamma = 1e-04

  Initial states:
    l = 1702.8136
    b = 45.1591
    s = -88.1484 150.3706 -65.4593 3.2371
```

```
  sigma:  0.0327

     AIC     AICc      BIC 
564.9718 570.2659 581.0295 

Training set error measures:
                   ME     RMSE      MAE         MPE     MAPE      MASE
Training set 1.924115 79.76684 60.79667 -0.07063202 2.307734 0.2906255
                   ACF1
Training set 0.01602256

Forecasts for Time Series ID: 1080
         Qtr1     Qtr2     Qtr3     Qtr4
1991 3812.271 3788.730 4049.744 3856.438
1992 3993.001 3969.459 4230.473 4037.167

Summary for ETS model of Time Series ID: 1081
ETS(M,A,A) 

Call:
 ets(y = train_data) 

  Smoothing parameters:
    alpha = 0.9995 
    beta  = 0.0023 
    gamma = 5e-04 

  Initial states:
    l = 1888.563 
```

```
    b = 33.4094
    s = 23.1438 72.1365 19.1813 -114.4617

  sigma:  0.0367

     AIC     AICc      BIC
573.9439 579.2380 590.0016

Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE       ACF1
Training set 6.871634 87.69787 72.47985 0.0985388 2.795652 0.3436913 0.03455427

Forecasts for Time Series ID: 1081
         Qtr1     Qtr2     Qtr3     Qtr4
1991 3573.155 3740.908 3827.907 3813.060
1992 3709.515 3877.268 3964.267 3949.420

Summary for ETS model of Time Series ID: 1082
ETS(M,A,M)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.2422
    beta  = 0.1704
    gamma = 1e-04

  Initial states:
    l = 2377.951
```

```
    b = 43.3423
    s = 1.0487 1.0225 0.9867 0.9422

  sigma:  0.0115

     AIC     AICc      BIC
496.4660 501.7601 512.5237

Training set error measures:
                   ME     RMSE      MAE       MPE      MAPE      MASE
Training set 5.931956 35.78694 27.19905 0.1352203 0.8152402 0.1353752
                   ACF1
Training set 0.03258457

Forecasts for Time Series ID: 1082
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4419.810 4715.005 4976.054 5195.337
1992 4750.457 5061.260 5334.891 5563.353

Summary for ETS model of Time Series ID: 1083
ETS(A,A,A)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.7499
    beta  = 1e-04
    gamma = 1e-04
```

```
  Initial states:
    l = 3242.0501
    b = 21.9246
    s = 358.7389 11.5206 -75.322 -294.9374

  sigma:  49.1107

     AIC     AICc      BIC
518.3536 523.6477 534.4113

Training set error measures:
                   ME     RMSE      MAE         MPE    MAPE      MASE
Training set -0.71843 44.42229 35.77698 -0.05405098 1.01324 0.3750876
                   ACF1
Training set 0.01346436

Forecasts for Time Series ID: 1083
         Qtr1     Qtr2     Qtr3     Qtr4
1991 3909.280 4150.809 4259.578 4628.720
1992 3996.966 4238.495 4347.263 4716.405

Summary for ETS model of Time Series ID: 1084
ETS(M,Ad,M)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.5373
    beta  = 1e-04
```

```
    gamma = 0.4627
    phi   = 0.9785

  Initial states:
    l = 5267.0428
    b = 29.8147
    s = 0.9979 1.0024 1.0012 0.9985

  sigma:  0.0066

     AIC     AICc      BIC
496.2161 502.8828 514.0580

Training set error measures:
                    ME     RMSE      MAE           MPE      MAPE    MASE
Training set 0.2210335 34.24906 26.10674 -0.0004569279 0.4508537 0.33851
                  ACF1
Training set 0.1174297

Forecasts for Time Series ID: 1084
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6017.635 6122.609 6168.815 6238.147
1992 6060.471 6165.179 6210.712 6279.535

Summary for ETS model of Time Series ID: 1085
ETS(M,N,A)

Call:
 ets(y = train_data)
```

```
  Smoothing parameters:
    alpha = 0.6737
    gamma = 0.3262

  Initial states:
    l = 3710.5868
    s = 484.3356 565.1373 5.645 -1055.118

  sigma:  0.032

     AIC     AICc      BIC
593.9074 597.0185 606.3967

Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE
Training set 29.94298 114.2241 90.80994 0.5460934 2.387981 0.5334818
                    ACF1
Training set -0.09014681

Forecasts for Time Series ID: 1085
         Qtr1     Qtr2     Qtr3     Qtr4
1991 3471.412 4818.536 5269.658 5263.200
1992 3471.412 4818.536 5269.658 5263.200

Summary for ETS model of Time Series ID: 1086
ETS(M,A,A)

Call:
 ets(y = train_data)
```

```
  Smoothing parameters:
    alpha = 0.643
    beta  = 0.0648
    gamma = 1e-04

  Initial states:
    l = 4896.746
    b = 71.0695
    s = -179.8399 385.6297 -140.4148 -65.3751

  sigma:  0.0325

     AIC     AICc      BIC
642.5128 647.8069 658.5705

Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE
Training set 24.36184 185.2628 154.5381 0.2332154 2.462462 0.4272918
                    ACF1
Training set -0.05958893

Forecasts for Time Series ID: 1086
         Qtr1     Qtr2     Qtr3     Qtr4
1991 8624.299 8689.806 9356.371 8931.480
1992 9186.444 9251.951 9918.516 9493.625

Summary for ETS model of Time Series ID: 1087
ETS(M,N,M)

Call:
```

```
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.9718
    gamma = 1e-04

  Initial states:
    l = 2247.14
    s = 1.0316 1.017 1.0128 0.9386

  sigma:  0.0359

     AIC     AICc      BIC
568.8118 571.9229 581.3012

Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE
Training set 28.33023 86.55504 70.95904 0.9519572 2.770329 0.4621504
                    ACF1
Training set -0.04948401

Forecasts for Time Series ID: 1087
         Qtr1     Qtr2     Qtr3     Qtr4
1991 3245.251 3501.777 3516.239 3566.816
1992 3245.251 3501.777 3516.240 3566.816

Summary for ETS model of Time Series ID: 1088
ETS(M,A,A)

Call:
```

```
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.4886
    beta  = 0.1301
    gamma = 7e-04

  Initial states:
    l = 5853.8937
    b = 14.4051
    s = 389.1755 194.7335 -97.6995 -486.2096

  sigma:  0.0101

     AIC     AICc      BIC
541.1466 546.4407 557.2043

Training set error measures:
                   ME     RMSE      MAE       MPE      MAPE      MASE
Training set 10.79743 57.72596 47.44919 0.1542899 0.7493555 0.3252406
                     ACF1
Training set -0.006368703

Forecasts for Time Series ID: 1088
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6944.965 7409.671 7778.381 8049.040
1992 7249.731 7714.437 8083.147 8353.806

Summary for ETS model of Time Series ID: 1089
ETS(M,A,A)
```

```
Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.6226
    beta  = 0.2092
    gamma = 0.1807

  Initial states:
    l = 4029.6353
    b = 95.1436
    s = -84.3884 -2.0277 24.5541 61.862

  sigma:  0.0075

     AIC     AICc      BIC
499.0721 504.3663 515.1299

Training set error measures:
                    ME     RMSE      MAE        MPE      MAPE      MASE
Training set -4.717637 36.10199 26.61701 -0.1052447 0.5034983 0.1484599
                  ACF1
Training set 0.1097611

Forecasts for Time Series ID: 1089
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6207.947 6264.001 6235.035 6256.693
1992 6414.821 6470.875 6441.909 6463.567
```

```
Summary for ETS model of Time Series ID: 1090
ETS(M,Ad,M)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.7471
    beta  = 1e-04
    gamma = 1e-04
    phi   = 0.98

  Initial states:
    l = 4017.1269
    b = 85.0048
    s = 0.9503 0.994 0.986 1.0697

  sigma:  0.0091

     AIC     AICc      BIC
518.9016 525.5683 536.7435

Training set error measures:
                   ME    RMSE     MAE        MPE      MAPE      MASE       ACF1
Training set 5.546327 46.4525 34.6547 0.07613405 0.6244027 0.1442743 0.03733428

Forecasts for Time Series ID: 1090
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7152.494 6626.761 6713.713 6449.995
1992 7294.786 6755.299 6840.698 6568.973
```

```
Summary for ETS model of Time Series ID: 1091
ETS(M,Ad,A)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.559
    beta  = 0.1072
    gamma = 1e-04
    phi   = 0.9799

  Initial states:
    l = 4121.9491
    b = 72.548
    s = -61.1023 8.9406 62.0423 -9.8807

  sigma:  0.008

     AIC     AICc      BIC
504.8616 511.5283 522.7035

Training set error measures:
                  ME     RMSE      MAE        MPE      MAPE      MASE
Training set 2.12016 38.16251 26.98257 0.02549205 0.5138618 0.1548386
                   ACF1
Training set -0.1619771

Forecasts for Time Series ID: 1091
```

```
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6113.074 6226.800 6214.665 6184.771
1992 6275.327 6385.799 6370.475 6337.456

Summary for ETS model of Time Series ID: 1092
ETS(M,Ad,M)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.7149
    beta  = 1e-04
    gamma = 0.2851
    phi   = 0.9544

  Initial states:
    l = 4465.8572
    b = 58.8816
    s = 1.0023 0.9907 1.0007 1.0063

  sigma:  0.0136

     AIC     AICc      BIC
550.1664 556.8330 568.0083

Training set error measures:
                    ME     RMSE      MAE         MPE     MAPE      MASE
Training set -1.364126 62.50463 51.63617 -0.03918484 1.004489 0.3789811
                   ACF1
```

```
Training set 0.02925251

Forecasts for Time Series ID: 1092
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5633.523 5449.081 5491.340 5464.398
1992 5661.280 5474.681 5515.940 5487.743

Summary for ETS model of Time Series ID: 1093
ETS(M,Ad,M)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.999
    beta  = 0.0577
    gamma = 9e-04
    phi   = 0.9469

  Initial states:
    l = 4504.1432
    b = 75.8984
    s = 0.9793 1.0127 0.9958 1.0123

  sigma:  0.0183

     AIC     AICc      BIC
575.0270 581.6937 592.8689

Training set error measures:
```

```
                    ME     RMSE      MAE        MPE     MAPE      MASE
Training set -5.449743 80.13855 60.35934 -0.1210796 1.217747 0.3502645
                  ACF1
Training set 0.1325939

Forecasts for Time Series ID: 1093
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5326.879 5246.160 5341.142 5170.213
1992 5349.608 5267.332 5361.531 5188.883

Summary for ETS model of Time Series ID: 1094
ETS(A,Ad,A)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.0213
    beta  = 2e-04
    gamma = 1e-04
    phi   = 0.9784

  Initial states:
    l = 4095.8717
    b = 75.8935
    s = -69.9581 -56.0878 14.7504 111.2956

  sigma:  47.9863

     AIC     AICc      BIC
```

```
517.0760 523.7426 534.9179

Training set error measures:
                    ME     RMSE      MAE         MPE      MAPE      MASE
Training set -3.600884 42.79818 33.52537 -0.08709027 0.6229974 0.1723558
                 ACF1
Training set 0.303078

Forecasts for Time Series ID: 1094
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6355.198 6286.486 6242.881 6255.648
1992 6462.960 6391.925 6346.046 6356.588

Summary for ETS model of Time Series ID: 1095
ETS(M,A,M)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.398
    beta  = 0.398
    gamma = 1e-04

  Initial states:
    l = 2617.4518
    b = 45.1709
    s = 1.0512 0.9613 1.0301 0.9574

  sigma:  0.0107
```

```
     AIC     AICc      BIC
496.1205 501.4146 512.1782

Training set error measures:
                   ME     RMSE     MAE        MPE      MAPE      MASE
Training set 3.009087 35.98211 27.3833 0.06263172 0.7595088 0.1388355
                    ACF1
Training set -0.08659791

Forecasts for Time Series ID: 1095
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4717.478 5174.995 4922.527 5484.373
1992 5087.993 5573.617 5294.538 5891.159

Summary for ETS model of Time Series ID: 1096
ETS(M,A,M)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.4945
    beta  = 1e-04
    gamma = 1e-04

  Initial states:
    l = 2305.2421
    b = 50.6527
    s = 1.0522 1.2401 0.853 0.8547
```

```
  sigma:  0.0552

     AIC     AICc      BIC
632.8530 638.1471 648.9107

Training set error measures:
                   ME     RMSE      MAE        MPE     MAPE      MASE
Training set 17.17658 160.1584 122.1765 0.09841051 3.841434 0.4401132
                    ACF1
Training set -0.09614029

Forecasts for Time Series ID: 1096
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4258.048 4292.556 6303.632 5402.045
1992 4431.501 4465.653 6555.287 5615.576

Summary for ETS model of Time Series ID: 1097
ETS(M,Ad,M)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.308
    beta  = 0.308
    gamma = 0.6895
    phi   = 0.98

  Initial states:
```

```
    l = 2716.8609
    b = 81.7203
    s = 0.9878 1.0079 1.0195 0.9847

  sigma:  0.0062

     AIC     AICc      BIC
461.6466 468.3133 479.4885

Training set error measures:
                   ME    RMSE      MAE        MPE      MAPE      MASE      ACF1
Training set 4.347336 22.8431 18.57441 0.08672987 0.4525664 0.0725648 0.1832684

Forecasts for Time Series ID: 1097
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5497.854 5825.397 5926.337 5928.330
1992 5810.074 6144.937 6240.485 6232.160

Summary for ETS model of Time Series ID: 1098
ETS(M,A,A)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.3723
    beta  = 6e-04
    gamma = 0.6277

  Initial states:
```

```
    l = 3180.4302
    b = 68.1737
    s = 375.3964 -168.6716 -133.3057 -73.4191

  sigma:  0.0253

     AIC     AICc      BIC
592.3488 597.6429 608.4065

Training set error measures:
                      ME     RMSE      MAE         MPE     MAPE      MASE
Training set -0.01726335 109.2853 85.39705 -0.09708652 1.854214 0.3163908
                  ACF1
Training set 0.1439441

Forecasts for Time Series ID: 1098
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6048.888 6243.274 6192.496 6889.292
1992 6321.581 6515.967 6465.189 7161.985

Summary for ETS model of Time Series ID: 1099
ETS(M,A,M)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.2422
    beta  = 0.1704
    gamma = 1e-04
```

```
  Initial states:
    l = 2377.951
    b = 43.3423
    s = 1.0487 1.0225 0.9867 0.9422

  sigma:  0.0115

     AIC     AICc      BIC
496.4660 501.7601 512.5237

Training set error measures:
                   ME     RMSE      MAE       MPE      MAPE      MASE
Training set 5.931956 35.78694 27.19905 0.1352203 0.8152402 0.1353752
                   ACF1
Training set 0.03258457

Forecasts for Time Series ID: 1099
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4419.810 4715.005 4976.054 5195.337
1992 4750.457 5061.260 5334.891 5563.353

Summary for ETS model of Time Series ID: 1100
ETS(M,N,M)

Call:
 ets(y = train_data)

  Smoothing parameters:
    alpha = 0.3675
```

```
    gamma = 0.0038

  Initial states:
    l = 5463.5524
    s = 1.3718 1.1295 0.7902 0.7085

  sigma:  0.0507

     AIC     AICc      BIC 
667.5577 670.6688 680.0470 

Training set error measures:
                   ME     RMSE      MAE       MPE     MAPE      MASE
Training set 27.61646 303.1197 199.3364 0.3470265 3.394563 0.6703201
                    ACF1
Training set -0.05240952

Forecasts for Time Series ID: 1100
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4213.595 4699.284 6717.163 8157.150
1992 4213.610 4699.301 6717.187 8157.179
```

8.38 Code computing the average Mean Absolute Percentage Error (MAPE) and Symmetric Mean Absolute Percentage Error (sMAPE) for the ETS models and comparing its performance with the Theta and Damped Exponential Smoothing models, which serve as benchmarks (benchmark models fitted in Appendix 8.37)

```
# Calculate average MAPE and sMAPE for each method
avg_mape_ets <- mean(mape_ets, na.rm = TRUE)
avg_smape_ets <- mean(smape_ets, na.rm = TRUE)
avg_mape_theta <- mean(mape_theta, na.rm = TRUE)
avg_smape_theta <- mean(smape_theta, na.rm = TRUE)
avg_mape_damped <- mean(mape_damped, na.rm = TRUE)
avg_smape_damped <- mean(smape_damped, na.rm = TRUE)

# Store evaluation metrics for each model in a data frame
ets_batch_evaluation_metrics <- data.frame(
  Model = c("ETS", "Theta", "Damped Exponential Smoothing"),
  MAPE = c(avg_mape_ets, avg_mape_theta, avg_mape_damped),
  sMAPE = c(avg_smape_ets, avg_smape_theta, avg_smape_damped)
)

# Print the evaluation metrics for comparison
cat("Table 20: Error measures evaluating automatic ETS model's
    out-of-sample accuracy")
print(ets_batch_evaluation_metrics, row.names = FALSE)

# Select the model with the lowest values for MAPE
```

```
ets_batch_best_model_mape <- ets_batch_evaluation_metrics[which.min(
    ets_batch_evaluation_metrics$MAPE), ]

# Select the model with the lowest values for sMAPE
ets_batch_best_model_smape <- ets_batch_evaluation_metrics[which.min(
    ets_batch_evaluation_metrics$sMAPE), ]

# Print the best model
cat("Best model based on MAPE:", ets_batch_best_model_mape$Model, "\n")
cat("Best model based on sMAPE:", ets_batch_best_model_smape$Model, "\n")
```

8.39 Code printing summaries of automatically fitted TBATS models for each series (IDs 1001 to 1100) and printing respective forecasted values.

```
# Define the series IDs and criterion
ts_start <- 1001
ts_end <- 1100
criterion <- "aicc"
num_ts <- ts_end - ts_start + 1

# Initialize arrays to store MAPE and sMAPE for TBATS and benchmarks
mape_tbats <- numeric(num_ts)
mape_theta <- numeric(num_ts)
mape_damped <- numeric(num_ts)
smape_tbats <- numeric(num_ts)
smape_theta <- numeric(num_ts)
smape_damped <- numeric(num_ts)
```

```r
# Loop through each time series
for (s in ts_start:ts_end) {
  train_data <- M3[[s]]$x
  test_data <- M3[[s]]$xx
  h <- length(test_data)

  # Fit TBATS model
  tbats_fit <- tbats(train_data)
  # Print summary of the fitted TBATS model
  cat("Summary for TBATS model of Time Series ID:", s, "\n")
  print(summary(tbats_fit))
  cat("\n")  # Add a newline after each summary
  tbats_fcst <- forecast(tbats_fit, h = h)$mean
  # Print forecasts
  cat("Forecasts for Time Series ID:", s, "\n")
  print(tbats_fcst)
  cat("\n")  # Add a newline after printing forecasts

  # Calculate MAPE for TBATS
  mape_tbats[s - ts_start + 1] <- 100 * mean(abs(test_data - tbats_fcst) /
                                               test_data, na.rm = TRUE)
  # Calculate sMAPE for TBATS
  smape_tbats[s - ts_start + 1] <- 200 * mean(abs(test_data - tbats_fcst) /
                                        (abs(test_data) + abs(tbats_fcst)),
                                        na.rm = TRUE)

  # Fit Theta model
  theta_fit <- thetaf(train_data)
  # Print summary of the fitted Theta model
```

```
#cat("Summary for Theta model of Time Series ID:", s, "\n")
#print(summary(theta_fit))
#cat("\n")  # Add a newline after each summary
theta_fcst <- forecast(theta_fit, h = h)$mean
# Print forecasts
#cat("Forecasts for Time Series ID:", s, "\n")
#print(theta_fcst)
#cat("\n")  # Add a newline after printing forecasts

# Calculate MAPE for Theta
mape_theta[s - ts_start + 1] <- 100 * mean(abs(test_data - theta_fcst) /
                                               test_data, na.rm = TRUE)
# Calculate sMAPE for Theta
smape_theta[s - ts_start + 1] <- 200 * mean(abs(test_data - theta_fcst) /
                                      (abs(test_data) + abs(theta_fcst)),
                                       na.rm = TRUE)

# Fit Damped Exponential Smoothing model
tryCatch({
  damped_model <- ets(train_data, model = "ZZZ", damped = TRUE)
  damped_fcst <- forecast(damped_model, h = h)$mean
  # Calculate MAPE for Damped Exponential Smoothing
  mape_damped[s - ts_start + 1] <- 100 * mean(abs(test_data - damped_fcst) /
                                                test_data, na.rm = TRUE)
  # Calculate sMAPE for Damped Exponential Smoothing
  smape_damped[s - ts_start + 1] <- 200 * mean(abs(test_data - damped_fcst) /
                                      (abs(test_data) + abs(damped_fcst)),
                                      na.rm = TRUE)
}, error = function(e) {
```

```r
    mape_damped[s - ts_start + 1] <- NA  # Assign NA in case of error
    smape_damped[s - ts_start + 1] <- NA  # Assign NA in case of error
  })
}
```

```
Summary for TBATS model of Time Series ID: 1001
                  Length Class  Mode
lambda             0     -none- NULL
alpha              1     -none- numeric
beta               1     -none- numeric
damping.parameter  1     -none- numeric
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        2     -none- numeric
fitted.values     44     ts     numeric
errors            44     ts     numeric
x                 88     -none- numeric
seasonal.periods   0     -none- NULL
y                 44     ts     numeric
call               2     -none- call
series             1     -none- character
method             1     -none- character

Forecasts for Time Series ID: 1001
```

```
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7166.651 7269.799 7372.948 7476.097
1992 7579.245 7682.394 7785.542 7888.691
```

```
Summary for TBATS model of Time Series ID: 1002
                  Length Class  Mode
lambda             0     -none- NULL
alpha              1     -none- numeric
beta               1     -none- numeric
damping.parameter  1     -none- numeric
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        2     -none- numeric
fitted.values     44     ts     numeric
errors            44     ts     numeric
x                 88     -none- numeric
seasonal.periods   0     -none- NULL
y                 44     ts     numeric
call               2     -none- call
series             1     -none- character
method             1     -none- character
```

```
Forecasts for Time Series ID: 1002
         Qtr1     Qtr2     Qtr3     Qtr4
```

```
1991 6754.523 6841.132 6927.741 7014.350
1992 7100.960 7187.569 7274.178 7360.787

Summary for TBATS model of Time Series ID: 1003
                  Length Class  Mode
lambda             0     -none- NULL
alpha              1     -none- numeric
beta               0     -none- NULL
damping.parameter  0     -none- NULL
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        1     -none- numeric
fitted.values     44     ts     numeric
errors            44     ts     numeric
x                 44     -none- numeric
seasonal.periods   0     -none- NULL
y                 44     ts     numeric
call               2     -none- call
series             1     -none- character
method             1     -none- character

Forecasts for Time Series ID: 1003
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6685.525 6685.525 6685.525 6685.525
```

```
1992 6685.525 6685.525 6685.525 6685.525

Summary for TBATS model of Time Series ID: 1004
                  Length Class  Mode
lambda             0     -none- NULL
alpha              1     -none- numeric
beta               1     -none- numeric
damping.parameter  1     -none- numeric
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        2     -none- numeric
fitted.values     44     ts     numeric
errors            44     ts     numeric
x                 88     -none- numeric
seasonal.periods   0     -none- NULL
y                 44     ts     numeric
call               2     -none- call
series             1     -none- character
method             1     -none- character

Forecasts for Time Series ID: 1004
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5933.716 5976.238 6018.585 6060.758
1992 6102.758 6144.585 6186.240 6227.724
```

```
Summary for TBATS model of Time Series ID: 1005
                  Length Class  Mode
lambda             0     -none- NULL
alpha              1     -none- numeric
beta               1     -none- numeric
damping.parameter  1     -none- numeric
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        2     -none- numeric
fitted.values     44     ts     numeric
errors            44     ts     numeric
x                 88     -none- numeric
seasonal.periods   0     -none- NULL
y                 44     ts     numeric
call               2     -none- call
series             1     -none- character
method             1     -none- character

Forecasts for Time Series ID: 1005
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5725.946 5690.273 5661.735 5638.904
1992 5620.639 5606.028 5594.339 5584.987
```

Summary for TBATS model of Time Series ID: 1006

```
                  Length Class  Mode
lambda             0     -none- NULL
alpha              1     -none- numeric
beta               0     -none- NULL
damping.parameter  0     -none- NULL
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        1     -none- numeric
fitted.values     44     ts     numeric
errors            44     ts     numeric
x                 44     -none- numeric
seasonal.periods   0     -none- NULL
y                 44     ts     numeric
call               2     -none- call
series             1     -none- character
method             1     -none- character
```

Forecasts for Time Series ID: 1006

```
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5980.048 5980.048 5980.048 5980.048
1992 5980.048 5980.048 5980.048 5980.048
```

Summary for TBATS model of Time Series ID: 1007

```
                  Length Class  Mode
lambda              0    -none- NULL
alpha               1    -none- numeric
beta                0    -none- NULL
damping.parameter   0    -none- NULL
gamma.values        0    -none- NULL
ar.coefficients     1    -none- numeric
ma.coefficients     2    -none- numeric
likelihood          1    -none- numeric
optim.return.code   1    -none- numeric
variance            1    -none- numeric
AIC                 1    -none- numeric
parameters          2    -none- list
seed.states         4    -none- numeric
fitted.values      44    ts     numeric
errors             44    ts     numeric
x                 176    -none- numeric
seasonal.periods    0    -none- NULL
y                  44    ts     numeric
call                2    -none- call
series              1    -none- character
method              1    -none- character

Forecasts for Time Series ID: 1007
         Qtr1     Qtr2     Qtr3     Qtr4
1991 8557.739 8644.644 8742.101 8828.593
1992 8905.352 8973.474 9033.931 9087.585

Summary for TBATS model of Time Series ID: 1008
                  Length Class  Mode
```

```
lambda              1      -none- numeric
alpha               1      -none- numeric
beta                1      -none- numeric
damping.parameter   1      -none- numeric
gamma.values        0      -none- NULL
ar.coefficients     0      -none- NULL
ma.coefficients     0      -none- NULL
likelihood          1      -none- numeric
optim.return.code   1      -none- numeric
variance            1      -none- numeric
AIC                 1      -none- numeric
parameters          2      -none- list
seed.states         2      -none- numeric
fitted.values      44      ts     numeric
errors             44      ts     numeric
x                  88      -none- numeric
seasonal.periods    0      -none- NULL
y                  44      ts     numeric
call                2      -none- call
series              1      -none- character
method              1      -none- character

Forecasts for Time Series ID: 1008
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6270.826 6367.620 6465.905 6565.702
1992 6667.034 6769.927 6874.403 6980.486

Summary for TBATS model of Time Series ID: 1009
                  Length Class  Mode
lambda              1      -none- numeric
```

```
alpha              1      -none- numeric
beta               0      -none- NULL
damping.parameter  0      -none- NULL
gamma.values       0      -none- NULL
ar.coefficients    0      -none- NULL
ma.coefficients    0      -none- NULL
likelihood         1      -none- numeric
optim.return.code  1      -none- numeric
variance           1      -none- numeric
AIC                1      -none- numeric
parameters         2      -none- list
seed.states        1      -none- numeric
fitted.values     44      ts     numeric
errors            44      ts     numeric
x                 44      -none- numeric
seasonal.periods   0      -none- NULL
y                 44      ts     numeric
call               2      -none- call
series             1      -none- character
method             1      -none- character

Forecasts for Time Series ID: 1009
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6912.748 6912.748 6912.748 6912.748
1992 6912.748 6912.748 6912.748 6912.748

Summary for TBATS model of Time Series ID: 1010
                  Length Class  Mode
lambda             0      -none- NULL
alpha              1      -none- numeric
```

```
beta               1     -none- numeric
damping.parameter  1     -none- numeric
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        2     -none- numeric
fitted.values     44     ts     numeric
errors            44     ts     numeric
x                 88     -none- numeric
seasonal.periods   0     -none- NULL
y                 44     ts     numeric
call               2     -none- call
series             1     -none- character
method             1     -none- character

Forecasts for Time Series ID: 1010
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6849.801 6779.253 6722.815 6677.665
1992 6641.544 6612.648 6589.531 6571.037

Summary for TBATS model of Time Series ID: 1011
                  Length Class  Mode
lambda             0     -none- NULL
alpha              1     -none- numeric
beta               1     -none- numeric
```

```
damping.parameter  1     -none- numeric
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        2     -none- numeric
fitted.values     16     ts     numeric
errors            16     ts     numeric
x                 32     -none- numeric
seasonal.periods   0     -none- NULL
y                 16     ts     numeric
call               2     -none- call
series             1     -none- character
method             1     -none- character

Forecasts for Time Series ID: 1011
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5793.364 5834.437 5875.510 5916.584
1992 5957.657 5998.731 6039.804 6080.877

Summary for TBATS model of Time Series ID: 1012
                  Length Class  Mode
lambda             1     -none- numeric
alpha              1     -none- numeric
beta               1     -none- numeric
damping.parameter  1     -none- numeric
```

```
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        2     -none- numeric
fitted.values     44     ts     numeric
errors            44     ts     numeric
x                 88     -none- numeric
seasonal.periods   0     -none- NULL
y                 44     ts     numeric
call               2     -none- call
series             1     -none- character
method             1     -none- character

Forecasts for Time Series ID: 1012
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6994.008 6768.827 6545.474 6323.981
1992 6104.380 5886.707 5670.996 5457.286

Summary for TBATS model of Time Series ID: 1013
                  Length Class  Mode
lambda              0    -none- NULL
alpha               1    -none- numeric
beta                1    -none- numeric
damping.parameter   1    -none- numeric
gamma.one.values    1    -none- numeric
```

```
gamma.two.values    1    -none- numeric
ar.coefficients     0    -none- NULL
ma.coefficients     0    -none- NULL
likelihood          1    -none- numeric
optim.return.code   1    -none- numeric
variance            1    -none- numeric
AIC                 1    -none- numeric
parameters          2    -none- list
seed.states         4    -none- numeric
fitted.values      44    ts     numeric
errors             44    ts     numeric
x                 176    -none- numeric
seasonal.periods    1    -none- numeric
k.vector            1    -none- numeric
y                  44    ts     numeric
p                   1    -none- numeric
q                   1    -none- numeric
call                2    -none- call
series              1    -none- character
method              1    -none- character

Forecasts for Time Series ID: 1013
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7485.150 7501.067 7574.626 7753.795
1992 7875.322 7891.240 7964.799 8143.967

Summary for TBATS model of Time Series ID: 1014
                  Length Class  Mode
lambda             1     -none- numeric
alpha              1     -none- numeric
```

```
beta              1      -none- numeric
damping.parameter 1      -none- numeric
gamma.values      0      -none- NULL
ar.coefficients   0      -none- NULL
ma.coefficients   0      -none- NULL
likelihood        1      -none- numeric
optim.return.code 1      -none- numeric
variance          1      -none- numeric
AIC               1      -none- numeric
parameters        2      -none- list
seed.states       2      -none- numeric
fitted.values    44      ts     numeric
errors           44      ts     numeric
x                88      -none- numeric
seasonal.periods  0      -none- NULL
y                44      ts     numeric
call              2      -none- call
series            1      -none- character
method            1      -none- character

Forecasts for Time Series ID: 1014
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7578.990 7842.703 8113.929 8392.834
1992 8679.588 8974.364 9277.337 9588.685


Summary for TBATS model of Time Series ID: 1015
                  Length Class  Mode
lambda            0      -none- NULL
alpha             1      -none- numeric
beta              1      -none- numeric
```

```
damping.parameter  1      -none- numeric
gamma.values       0      -none- NULL
ar.coefficients    0      -none- NULL
ma.coefficients    0      -none- NULL
likelihood         1      -none- numeric
optim.return.code  1      -none- numeric
variance           1      -none- numeric
AIC                1      -none- numeric
parameters         2      -none- list
seed.states        2      -none- numeric
fitted.values     44      ts     numeric
errors            44      ts     numeric
x                 88      -none- numeric
seasonal.periods   0      -none- NULL
y                 44      ts     numeric
call               2      -none- call
series             1      -none- character
method             1      -none- character

Forecasts for Time Series ID: 1015
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7184.269 7289.161 7394.052 7498.944
1992 7603.836 7708.728 7813.620 7918.512

Summary for TBATS model of Time Series ID: 1016
                  Length Class  Mode
lambda             1      -none- numeric
alpha              1      -none- numeric
beta               1      -none- numeric
damping.parameter  1      -none- numeric
```

```
gamma.values       0      -none- NULL
ar.coefficients    0      -none- NULL
ma.coefficients    0      -none- NULL
likelihood         1      -none- numeric
optim.return.code  1      -none- numeric
variance           1      -none- numeric
AIC                1      -none- numeric
parameters         2      -none- list
seed.states        2      -none- numeric
fitted.values     44      ts     numeric
errors            44      ts     numeric
x                 88      -none- numeric
seasonal.periods   0      -none- NULL
y                 44      ts     numeric
call               2      -none- call
series             1      -none- character
method             1      -none- character

Forecasts for Time Series ID: 1016
         Qtr1     Qtr2     Qtr3     Qtr4
1991 9019.896 8934.411 8866.606 8812.731
1992 8769.867 8735.725 8708.507 8686.794

Summary for TBATS model of Time Series ID: 1017
                  Length Class  Mode
lambda             0      -none- NULL
alpha              1      -none- numeric
beta               0      -none- NULL
damping.parameter  0      -none- NULL
gamma.values       0      -none- NULL
```

```
ar.coefficients    0      -none- NULL
ma.coefficients    0      -none- NULL
likelihood         1      -none- numeric
optim.return.code  1      -none- numeric
variance           1      -none- numeric
AIC                1      -none- numeric
parameters         2      -none- list
seed.states        1      -none- numeric
fitted.values     44      ts     numeric
errors            44      ts     numeric
x                 44      -none- numeric
seasonal.periods   0      -none- NULL
y                 44      ts     numeric
call               2      -none- call
series             1      -none- character
method             1      -none- character

Forecasts for Time Series ID: 1017
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6525.453 6525.453 6525.453 6525.453
1992 6525.453 6525.453 6525.453 6525.453

Summary for TBATS model of Time Series ID: 1018
                  Length Class  Mode
lambda             1      -none- numeric
alpha              1      -none- numeric
beta               0      -none- NULL
damping.parameter  0      -none- NULL
gamma.values       0      -none- NULL
ar.coefficients    0      -none- NULL
```

```
ma.coefficients    0      -none- NULL
likelihood         1      -none- numeric
optim.return.code  1      -none- numeric
variance           1      -none- numeric
AIC                1      -none- numeric
parameters         2      -none- list
seed.states        1      -none- numeric
fitted.values     44      ts     numeric
errors            44      ts     numeric
x                 44      -none- numeric
seasonal.periods   0      -none- NULL
y                 44      ts     numeric
call               2      -none- call
series             1      -none- character
method             1      -none- character

Forecasts for Time Series ID: 1018
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5149.318 5149.318 5149.318 5149.318
1992 5149.318 5149.318 5149.318 5149.318

Summary for TBATS model of Time Series ID: 1019
                  Length Class  Mode
lambda             0      -none- NULL
alpha              1      -none- numeric
beta               0      -none- NULL
damping.parameter  0      -none- NULL
gamma.values       0      -none- NULL
ar.coefficients    0      -none- NULL
ma.coefficients    0      -none- NULL
```

```
likelihood          1     -none- numeric
optim.return.code   1     -none- numeric
variance            1     -none- numeric
AIC                 1     -none- numeric
parameters          2     -none- list
seed.states         1     -none- numeric
fitted.values      44     ts     numeric
errors             44     ts     numeric
x                  44     -none- numeric
seasonal.periods    0     -none- NULL
y                  44     ts     numeric
call                2     -none- call
series              1     -none- character
method              1     -none- character

Forecasts for Time Series ID: 1019
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6182.786 6182.786 6182.786 6182.786
1992 6182.786 6182.786 6182.786 6182.786

Summary for TBATS model of Time Series ID: 1020
                  Length Class  Mode
lambda              0     -none- NULL
alpha               1     -none- numeric
beta                1     -none- numeric
damping.parameter   1     -none- numeric
gamma.values        0     -none- NULL
ar.coefficients     0     -none- NULL
ma.coefficients     0     -none- NULL
likelihood          1     -none- numeric
```

```
optim.return.code  1      -none- numeric
variance           1      -none- numeric
AIC                1      -none- numeric
parameters         2      -none- list
seed.states        2      -none- numeric
fitted.values     44      ts     numeric
errors            44      ts     numeric
x                 88      -none- numeric
seasonal.periods   0      -none- NULL
y                 44      ts     numeric
call               2      -none- call
series             1      -none- character
method             1      -none- character

Forecasts for Time Series ID: 1020
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6300.322 6312.004 6323.687 6335.369
1992 6347.051 6358.733 6370.416 6382.098

Summary for TBATS model of Time Series ID: 1021
                  Length Class  Mode
lambda             0      -none- NULL
alpha              1      -none- numeric
beta               0      -none- NULL
damping.parameter  0      -none- NULL
gamma.values       0      -none- NULL
ar.coefficients    0      -none- NULL
ma.coefficients    0      -none- NULL
likelihood         1      -none- numeric
optim.return.code  1      -none- numeric
```

```
variance           1      -none- numeric
AIC                1      -none- numeric
parameters         2      -none- list
seed.states        1      -none- numeric
fitted.values     44      ts     numeric
errors            44      ts     numeric
x                 44      -none- numeric
seasonal.periods   0      -none- NULL
y                 44      ts     numeric
call               2      -none- call
series             1      -none- character
method             1      -none- character

Forecasts for Time Series ID: 1021
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6855.378 6855.378 6855.378 6855.378
1992 6855.378 6855.378 6855.378 6855.378

Summary for TBATS model of Time Series ID: 1022
                  Length Class  Mode
lambda             0      -none- NULL
alpha              1      -none- numeric
beta               0      -none- NULL
damping.parameter  0      -none- NULL
gamma.values       0      -none- NULL
ar.coefficients    0      -none- NULL
ma.coefficients    0      -none- NULL
likelihood         1      -none- numeric
optim.return.code  1      -none- numeric
variance           1      -none- numeric
```

```
AIC                 1     -none- numeric
parameters          2     -none- list
seed.states         1     -none- numeric
fitted.values      44     ts     numeric
errors             44     ts     numeric
x                  44     -none- numeric
seasonal.periods    0     -none- NULL
y                  44     ts     numeric
call                2     -none- call
series              1     -none- character
method              1     -none- character

Forecasts for Time Series ID: 1022
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6068.451 6068.451 6068.451 6068.451
1992 6068.451 6068.451 6068.451 6068.451

Summary for TBATS model of Time Series ID: 1023
                  Length Class  Mode
lambda              1     -none- numeric
alpha               1     -none- numeric
beta                1     -none- numeric
damping.parameter   1     -none- numeric
gamma.values        0     -none- NULL
ar.coefficients     0     -none- NULL
ma.coefficients     0     -none- NULL
likelihood          1     -none- numeric
optim.return.code   1     -none- numeric
variance            1     -none- numeric
AIC                 1     -none- numeric
```

```
parameters         2     -none- list
seed.states        2     -none- numeric
fitted.values     44     ts     numeric
errors            44     ts     numeric
x                 88     -none- numeric
seasonal.periods   0     -none- NULL
y                 44     ts     numeric
call               2     -none- call
series             1     -none- character
method             1     -none- character

Forecasts for Time Series ID: 1023
         Qtr1     Qtr2     Qtr3     Qtr4
1991 8432.281 8582.437 8733.394 8885.147
1992 9037.690 9191.018 9345.125 9500.007

Summary for TBATS model of Time Series ID: 1024
                  Length Class  Mode
lambda             1     -none- numeric
alpha              1     -none- numeric
beta               1     -none- numeric
damping.parameter  1     -none- numeric
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
```

```
seed.states        2     -none- numeric
fitted.values     44     ts     numeric
errors            44     ts     numeric
x                 88     -none- numeric
seasonal.periods   0     -none- NULL
y                 44     ts     numeric
call               2     -none- call
series             1     -none- character
method             1     -none- character
```

```
Forecasts for Time Series ID: 1024
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4243.675 4321.433 4400.552 4481.054
1992 4562.962 4646.300 4731.092 4817.362
```

```
Summary for TBATS model of Time Series ID: 1025
                  Length Class  Mode
lambda              0    -none- NULL
alpha               1    -none- numeric
beta                1    -none- numeric
damping.parameter   1    -none- numeric
gamma.values        0    -none- NULL
ar.coefficients     0    -none- NULL
ma.coefficients     2    -none- numeric
likelihood          1    -none- numeric
optim.return.code   1    -none- numeric
variance            1    -none- numeric
AIC                 1    -none- numeric
parameters          2    -none- list
seed.states         4    -none- numeric
```

```
fitted.values      44    ts     numeric
errors             44    ts     numeric
x                 176    -none- numeric
seasonal.periods    0    -none- NULL
y                  44    ts     numeric
call                2    -none- call
series              1    -none- character
method              1    -none- character

Forecasts for Time Series ID: 1025
         Qtr1     Qtr2     Qtr3     Qtr4
1991 8264.474 8204.669 8352.097 8487.434
1992 8622.770 8758.107 8893.443 9028.779

Summary for TBATS model of Time Series ID: 1026
                  Length Class  Mode
lambda             1     -none- numeric
alpha              1     -none- numeric
beta               1     -none- numeric
damping.parameter  1     -none- numeric
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        2     -none- numeric
fitted.values     44     ts     numeric
```

```
errors            44     ts     numeric
x                 88     -none- numeric
seasonal.periods   0     -none- NULL
y                 44     ts     numeric
call               2     -none- call
series             1     -none- character
method             1     -none- character

Forecasts for Time Series ID: 1026
         Qtr1     Qtr2     Qtr3     Qtr4
1991 8395.712 8548.943 8704.971 8863.846
1992 9025.622 9190.349 9358.084 9528.879

Summary for TBATS model of Time Series ID: 1027
                  Length Class  Mode
lambda             1     -none- numeric
alpha              1     -none- numeric
beta               1     -none- numeric
damping.parameter  1     -none- numeric
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        2     -none- numeric
fitted.values     44     ts     numeric
errors            44     ts     numeric
```

```
x                 88     -none- numeric
seasonal.periods   0     -none- NULL
y                 44     ts     numeric
call               2     -none- call
series             1     -none- character
method             1     -none- character

Forecasts for Time Series ID: 1027
          Qtr1      Qtr2      Qtr3      Qtr4
1991  9761.509  9988.383 10219.615 10455.274
1992 10695.425 10940.136 11189.477 11443.516

Summary for TBATS model of Time Series ID: 1028
                  Length Class  Mode
lambda             0     -none- NULL
alpha              1     -none- numeric
beta               1     -none- numeric
damping.parameter  1     -none- numeric
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        2     -none- numeric
fitted.values     44     ts     numeric
errors            44     ts     numeric
x                 88     -none- numeric
```

```
seasonal.periods   0     -none- NULL
y                 44     ts     numeric
call               2     -none- call
series             1     -none- character
method             1     -none- character

Forecasts for Time Series ID: 1028
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5449.988 5483.215 5516.442 5549.669
1992 5582.896 5616.123 5649.350 5682.577

Summary for TBATS model of Time Series ID: 1029
                  Length Class  Mode
lambda             0     -none- NULL
alpha              1     -none- numeric
beta               1     -none- numeric
damping.parameter  1     -none- numeric
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        2     -none- numeric
fitted.values     44     ts     numeric
errors            44     ts     numeric
x                 88     -none- numeric
seasonal.periods   0     -none- NULL
```

```
y                 44     ts     numeric
call               2     -none- call
series             1     -none- character
method             1     -none- character

Forecasts for Time Series ID: 1029
         Qtr1     Qtr2     Qtr3     Qtr4
1991 8040.555 8103.474 8166.392 8229.310
1992 8292.228 8355.147 8418.065 8480.983

Summary for TBATS model of Time Series ID: 1030
                  Length Class  Mode
lambda             0     -none- NULL
alpha              1     -none- numeric
beta               0     -none- NULL
damping.parameter  0     -none- NULL
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        1     -none- numeric
fitted.values     44     ts     numeric
errors            44     ts     numeric
x                 44     -none- numeric
seasonal.periods   0     -none- NULL
y                 44     ts     numeric
```

```
call               2     -none- call
series             1     -none- character
method             1     -none- character

Forecasts for Time Series ID: 1030
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4115.292 4115.292 4115.292 4115.292
1992 4115.292 4115.292 4115.292 4115.292

Summary for TBATS model of Time Series ID: 1031
                  Length Class  Mode
lambda             0     -none- NULL
alpha              1     -none- numeric
beta               0     -none- NULL
damping.parameter  0     -none- NULL
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        1     -none- numeric
fitted.values     44     ts     numeric
errors            44     ts     numeric
x                 44     -none- numeric
seasonal.periods   0     -none- NULL
y                 44     ts     numeric
call               2     -none- call
```

```
series             1     -none- character
method             1     -none- character

Forecasts for Time Series ID: 1031
         Qtr1     Qtr2     Qtr3     Qtr4
1991 8136.079 8136.079 8136.079 8136.079
1992 8136.079 8136.079 8136.079 8136.079

Summary for TBATS model of Time Series ID: 1032
                  Length Class  Mode
lambda             1     -none- numeric
alpha              1     -none- numeric
beta               1     -none- numeric
damping.parameter  1     -none- numeric
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        2     -none- numeric
fitted.values     44     ts     numeric
errors            44     ts     numeric
x                 88     -none- numeric
seasonal.periods   0     -none- NULL
y                 44     ts     numeric
call               2     -none- call
series             1     -none- character
```

```
method             1      -none- character
```

```
Forecasts for Time Series ID: 1032
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7874.983 7996.430 8119.745 8244.957
1992 8372.093 8501.185 8632.261 8765.353
```

```
Summary for TBATS model of Time Series ID: 1033
                  Length Class  Mode
lambda             0      -none- NULL
alpha              1      -none- numeric
beta               1      -none- numeric
damping.parameter  1      -none- numeric
gamma.values       0      -none- NULL
ar.coefficients    0      -none- NULL
ma.coefficients    0      -none- NULL
likelihood         1      -none- numeric
optim.return.code  1      -none- numeric
variance           1      -none- numeric
AIC                1      -none- numeric
parameters         2      -none- list
seed.states        2      -none- numeric
fitted.values     44      ts     numeric
errors            44      ts     numeric
x                 88      -none- numeric
seasonal.periods   0      -none- NULL
y                 44      ts     numeric
call               2      -none- call
series             1      -none- character
method             1      -none- character
```

```
Forecasts for Time Series ID: 1033

         Qtr1     Qtr2     Qtr3     Qtr4

1991 9282.714 9332.451 9382.188 9431.925

1992 9481.661 9531.398 9581.135 9630.872


Summary for TBATS model of Time Series ID: 1034

                  Length Class  Mode

lambda             0     -none- NULL

alpha              1     -none- numeric

beta               1     -none- numeric

damping.parameter  1     -none- numeric

gamma.values       0     -none- NULL

ar.coefficients    0     -none- NULL

ma.coefficients    0     -none- NULL

likelihood         1     -none- numeric

optim.return.code  1     -none- numeric

variance           1     -none- numeric

AIC                1     -none- numeric

parameters         2     -none- list

seed.states        2     -none- numeric

fitted.values     44     ts     numeric

errors            44     ts     numeric

x                 88     -none- numeric

seasonal.periods   0     -none- NULL

y                 44     ts     numeric

call               2     -none- call

series             1     -none- character

method             1     -none- character
```

```
Forecasts for Time Series ID: 1034

         Qtr1     Qtr2     Qtr3     Qtr4

1991 5288.286 5330.189 5371.308 5411.658

1992 5451.253 5490.107 5528.235 5565.649


Summary for TBATS model of Time Series ID: 1035

                  Length Class  Mode

lambda             1     -none- numeric

alpha              1     -none- numeric

beta               1     -none- numeric

damping.parameter  1     -none- numeric

gamma.values       0     -none- NULL

ar.coefficients    0     -none- NULL

ma.coefficients    0     -none- NULL

likelihood         1     -none- numeric

optim.return.code  1     -none- numeric

variance           1     -none- numeric

AIC                1     -none- numeric

parameters         2     -none- list

seed.states        2     -none- numeric

fitted.values     44     ts     numeric

errors            44     ts     numeric

x                 88     -none- numeric

seasonal.periods   0     -none- NULL

y                 44     ts     numeric

call               2     -none- call

series             1     -none- character

method             1     -none- character


Forecasts for Time Series ID: 1035
```

```
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5137.827 5205.842 5274.102 5342.605
1992 5411.351 5480.337 5549.563 5619.027

Summary for TBATS model of Time Series ID: 1036
                  Length Class  Mode
lambda             1     -none- numeric
alpha              1     -none- numeric
beta               1     -none- numeric
damping.parameter  1     -none- numeric
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        2     -none- numeric
fitted.values     44     ts     numeric
errors            44     ts     numeric
x                 88     -none- numeric
seasonal.periods   0     -none- NULL
y                 44     ts     numeric
call               2     -none- call
series             1     -none- character
method             1     -none- character

Forecasts for Time Series ID: 1036
         Qtr1     Qtr2     Qtr3     Qtr4
```

```
1991 5046.507 5096.004 5145.986 5196.458
1992 5247.425 5298.892 5350.864 5403.346

Summary for TBATS model of Time Series ID: 1037
                  Length Class  Mode
lambda             1     -none- numeric
alpha              1     -none- numeric
beta               1     -none- numeric
damping.parameter  1     -none- numeric
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        2     -none- numeric
fitted.values     44     ts     numeric
errors            44     ts     numeric
x                 88     -none- numeric
seasonal.periods   0     -none- NULL
y                 44     ts     numeric
call               2     -none- call
series             1     -none- character
method             1     -none- character

Forecasts for Time Series ID: 1037
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5326.834 5379.380 5432.443 5486.031
```

```
1992 5540.146 5594.796 5649.985 5705.718
```

```
Summary for TBATS model of Time Series ID: 1038
                  Length Class  Mode
lambda             0     -none- NULL
alpha              1     -none- numeric
beta               1     -none- numeric
damping.parameter  1     -none- numeric
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        2     -none- numeric
fitted.values     44     ts     numeric
errors            44     ts     numeric
x                 88     -none- numeric
seasonal.periods   0     -none- NULL
y                 44     ts     numeric
call               2     -none- call
series             1     -none- character
method             1     -none- character
```

```
Forecasts for Time Series ID: 1038
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4921.559 5004.431 5087.302 5170.173
1992 5253.044 5335.915 5418.786 5501.658
```

```
Summary for TBATS model of Time Series ID: 1039
                  Length Class  Mode
lambda             0     -none- NULL
alpha              1     -none- numeric
beta               1     -none- numeric
damping.parameter  1     -none- numeric
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        2     -none- numeric
fitted.values     44     ts     numeric
errors            44     ts     numeric
x                 88     -none- numeric
seasonal.periods   0     -none- NULL
y                 44     ts     numeric
call               2     -none- call
series             1     -none- character
method             1     -none- character

Forecasts for Time Series ID: 1039
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7238.655 7297.525 7356.396 7415.267
1992 7474.137 7533.008 7591.879 7650.749
```

Summary for TBATS model of Time Series ID: 1040

```
                  Length Class  Mode
lambda             1     -none- numeric
alpha              1     -none- numeric
beta               1     -none- numeric
damping.parameter  1     -none- numeric
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        2     -none- numeric
fitted.values     44     ts     numeric
errors            44     ts     numeric
x                 88     -none- numeric
seasonal.periods   0     -none- NULL
y                 44     ts     numeric
call               2     -none- call
series             1     -none- character
method             1     -none- character
```

Forecasts for Time Series ID: 1040

```
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5775.699 5915.049 6056.980 6201.519
1992 6348.697 6498.542 6651.083 6806.349
```

Summary for TBATS model of Time Series ID: 1041

```
                  Length Class  Mode
lambda             1     -none- numeric
alpha              1     -none- numeric
beta               1     -none- numeric
damping.parameter  1     -none- numeric
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        2     -none- numeric
fitted.values     44     ts     numeric
errors            44     ts     numeric
x                 88     -none- numeric
seasonal.periods   0     -none- NULL
y                 44     ts     numeric
call               2     -none- call
series             1     -none- character
method             1     -none- character
```

```
Forecasts for Time Series ID: 1041
          Qtr1      Qtr2      Qtr3      Qtr4
1991  9761.509  9988.383 10219.615 10455.274
1992 10695.425 10940.136 11189.477 11443.516
```

```
Summary for TBATS model of Time Series ID: 1042
                  Length Class  Mode
```

```
lambda             0      -none- NULL
alpha              1      -none- numeric
beta               0      -none- NULL
damping.parameter  0      -none- NULL
gamma.values       0      -none- NULL
ar.coefficients    0      -none- NULL
ma.coefficients    0      -none- NULL
likelihood         1      -none- numeric
optim.return.code  1      -none- numeric
variance           1      -none- numeric
AIC                1      -none- numeric
parameters         2      -none- list
seed.states        1      -none- numeric
fitted.values     44      ts     numeric
errors            44      ts     numeric
x                 44      -none- numeric
seasonal.periods   0      -none- NULL
y                 44      ts     numeric
call               2      -none- call
series             1      -none- character
method             1      -none- character

Forecasts for Time Series ID: 1042
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5678.516 5678.516 5678.516 5678.516
1992 5678.516 5678.516 5678.516 5678.516

Summary for TBATS model of Time Series ID: 1043
                  Length Class  Mode
lambda             1      -none- numeric
```

```
alpha              1      -none- numeric
beta               1      -none- numeric
damping.parameter  1      -none- numeric
gamma.values       0      -none- NULL
ar.coefficients    0      -none- NULL
ma.coefficients    0      -none- NULL
likelihood         1      -none- numeric
optim.return.code  1      -none- numeric
variance           1      -none- numeric
AIC                1      -none- numeric
parameters         2      -none- list
seed.states        2      -none- numeric
fitted.values     44      ts     numeric
errors            44      ts     numeric
x                 88      -none- numeric
seasonal.periods   0      -none- NULL
y                 44      ts     numeric
call               2      -none- call
series             1      -none- character
method             1      -none- character

Forecasts for Time Series ID: 1043
          Qtr1      Qtr2      Qtr3      Qtr4
1991  9464.080  9678.341  9896.438 10118.423
1992 10344.347 10574.260 10808.217 11046.268

Summary for TBATS model of Time Series ID: 1044
                  Length Class  Mode
lambda             1      -none- numeric
alpha              1      -none- numeric
```

```
beta              1      -none- numeric
damping.parameter 1      -none- numeric
gamma.values      0      -none- NULL
ar.coefficients   0      -none- NULL
ma.coefficients   0      -none- NULL
likelihood        1      -none- numeric
optim.return.code 1      -none- numeric
variance          1      -none- numeric
AIC               1      -none- numeric
parameters        2      -none- list
seed.states       2      -none- numeric
fitted.values    44      ts     numeric
errors           44      ts     numeric
x                88      -none- numeric
seasonal.periods  0      -none- NULL
y                44      ts     numeric
call              2      -none- call
series            1      -none- character
method            1      -none- character

Forecasts for Time Series ID: 1044
          Qtr1      Qtr2      Qtr3      Qtr4
1991  9761.509  9988.383 10219.615 10455.274
1992 10695.425 10940.136 11189.477 11443.516

Summary for TBATS model of Time Series ID: 1045
                  Length Class  Mode
lambda            0      -none- NULL
alpha             1      -none- numeric
beta              0      -none- NULL
```

```
damping.parameter  0      -none- NULL
gamma.values       0      -none- NULL
ar.coefficients    0      -none- NULL
ma.coefficients    0      -none- NULL
likelihood         1      -none- numeric
optim.return.code  1      -none- numeric
variance           1      -none- numeric
AIC                1      -none- numeric
parameters         2      -none- list
seed.states        1      -none- numeric
fitted.values     44      ts     numeric
errors            44      ts     numeric
x                 44      -none- numeric
seasonal.periods   0      -none- NULL
y                 44      ts     numeric
call               2      -none- call
series             1      -none- character
method             1      -none- character

Forecasts for Time Series ID: 1045
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7310.578 7310.578 7310.578 7310.578
1992 7310.578 7310.578 7310.578 7310.578

Summary for TBATS model of Time Series ID: 1046
                  Length Class  Mode
lambda             0      -none- NULL
alpha              1      -none- numeric
beta               1      -none- numeric
damping.parameter  1      -none- numeric
```

```
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        2     -none- numeric
fitted.values     44     ts     numeric
errors            44     ts     numeric
x                 88     -none- numeric
seasonal.periods   0     -none- NULL
y                 44     ts     numeric
call               2     -none- call
series             1     -none- character
method             1     -none- character

Forecasts for Time Series ID: 1046
         Qtr1     Qtr2     Qtr3     Qtr4
1991 8912.013 8958.282 9004.552 9050.821
1992 9097.091 9143.360 9189.629 9235.899

Summary for TBATS model of Time Series ID: 1047
                  Length Class  Mode
lambda             0     -none- NULL
alpha              1     -none- numeric
beta               1     -none- numeric
damping.parameter  1     -none- numeric
gamma.values       0     -none- NULL
```

```
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        2     -none- numeric
fitted.values     44     ts     numeric
errors            44     ts     numeric
x                 88     -none- numeric
seasonal.periods   0     -none- NULL
y                 44     ts     numeric
call               2     -none- call
series             1     -none- character
method             1     -none- character

Forecasts for Time Series ID: 1047
         Qtr1     Qtr2     Qtr3     Qtr4
1991 9282.714 9332.451 9382.188 9431.925
1992 9481.661 9531.398 9581.135 9630.872

Summary for TBATS model of Time Series ID: 1048
                  Length Class  Mode
lambda             1     -none- numeric
alpha              1     -none- numeric
beta               1     -none- numeric
damping.parameter  1     -none- numeric
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
```

```
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        2     -none- numeric
fitted.values     44     ts     numeric
errors            44     ts     numeric
x                 88     -none- numeric
seasonal.periods   0     -none- NULL
y                 44     ts     numeric
call               2     -none- call
series             1     -none- character
method             1     -none- character

Forecasts for Time Series ID: 1048
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7322.682 7396.406 7470.129 7543.852
1992 7617.576 7691.299 7765.022 7838.745

Summary for TBATS model of Time Series ID: 1049
                  Length Class  Mode
lambda              1    -none- numeric
alpha               1    -none- numeric
beta                1    -none- numeric
damping.parameter   1    -none- numeric
gamma.one.values    1    -none- numeric
gamma.two.values    1    -none- numeric
ar.coefficients     0    -none- NULL
```

```
ma.coefficients     0    -none- NULL
likelihood          1    -none- numeric
optim.return.code   1    -none- numeric
variance            1    -none- numeric
AIC                 1    -none- numeric
parameters          2    -none- list
seed.states         4    -none- numeric
fitted.values      44    ts     numeric
errors             44    ts     numeric
x                 176    -none- numeric
seasonal.periods    1    -none- numeric
k.vector            1    -none- numeric
y                  44    ts     numeric
p                   1    -none- numeric
q                   1    -none- numeric
call                2    -none- call
series              1    -none- character
method              1    -none- character

Forecasts for Time Series ID: 1049
         Qtr1     Qtr2     Qtr3     Qtr4
1991 3503.373 3175.553 3778.166 4215.064
1992 3677.838 3344.838 3956.724 4399.731

Summary for TBATS model of Time Series ID: 1050
                  Length Class  Mode
lambda             1     -none- numeric
alpha              1     -none- numeric
beta               1     -none- numeric
damping.parameter  1     -none- numeric
```

```
gamma.values       0      -none- NULL
ar.coefficients    0      -none- NULL
ma.coefficients    0      -none- NULL
likelihood         1      -none- numeric
optim.return.code  1      -none- numeric
variance           1      -none- numeric
AIC                1      -none- numeric
parameters         2      -none- list
seed.states        2      -none- numeric
fitted.values     44      ts     numeric
errors            44      ts     numeric
x                 88      -none- numeric
seasonal.periods   0      -none- NULL
y                 44      ts     numeric
call               2      -none- call
series             1      -none- character
method             1      -none- character

Forecasts for Time Series ID: 1050
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4186.779 4250.954 4316.114 4382.272
1992 4449.445 4517.647 4586.895 4657.204

Summary for TBATS model of Time Series ID: 1051
                  Length Class  Mode
lambda             1      -none- numeric
alpha              1      -none- numeric
beta               1      -none- numeric
damping.parameter  1      -none- numeric
gamma.values       0      -none- NULL
```

```
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        2     -none- numeric
fitted.values     44     ts     numeric
errors            44     ts     numeric
x                 88     -none- numeric
seasonal.periods   0     -none- NULL
y                 44     ts     numeric
call               2     -none- call
series             1     -none- character
method             1     -none- character

Forecasts for Time Series ID: 1051
         Qtr1     Qtr2     Qtr3     Qtr4
1991 3840.012 3909.152 3979.463 4050.963
1992 4123.673 4197.610 4272.794 4349.246

Summary for TBATS model of Time Series ID: 1052
                  Length Class  Mode
lambda             1     -none- numeric
alpha              1     -none- numeric
beta               1     -none- numeric
damping.parameter  1     -none- numeric
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
```

```
ma.coefficients    0      -none- NULL
likelihood         1      -none- numeric
optim.return.code  1      -none- numeric
variance           1      -none- numeric
AIC                1      -none- numeric
parameters         2      -none- list
seed.states        2      -none- numeric
fitted.values     44      ts     numeric
errors            44      ts     numeric
x                 88      -none- numeric
seasonal.periods   0      -none- NULL
y                 44      ts     numeric
call               2      -none- call
series             1      -none- character
method             1      -none- character

Forecasts for Time Series ID: 1052
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4243.675 4321.433 4400.552 4481.054
1992 4562.962 4646.300 4731.092 4817.362

Summary for TBATS model of Time Series ID: 1053
                  Length Class  Mode
lambda             0      -none- NULL
alpha              1      -none- numeric
beta               1      -none- numeric
damping.parameter  1      -none- numeric
gamma.values       0      -none- NULL
ar.coefficients    0      -none- NULL
ma.coefficients    0      -none- NULL
```

```
likelihood         1      -none- numeric
optim.return.code  1      -none- numeric
variance           1      -none- numeric
AIC                1      -none- numeric
parameters         2      -none- list
seed.states        2      -none- numeric
fitted.values     44      ts     numeric
errors            44      ts     numeric
x                 88      -none- numeric
seasonal.periods   0      -none- NULL
y                 44      ts     numeric
call               2      -none- call
series             1      -none- character
method             1      -none- character

Forecasts for Time Series ID: 1053
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4326.280 4306.871 4291.344 4278.922
1992 4268.984 4261.034 4254.674 4249.586

Summary for TBATS model of Time Series ID: 1054
                  Length Class  Mode
lambda             1      -none- numeric
alpha              1      -none- numeric
beta               1      -none- numeric
damping.parameter  1      -none- numeric
gamma.values       0      -none- NULL
ar.coefficients    0      -none- NULL
ma.coefficients    0      -none- NULL
likelihood         1      -none- numeric
```

```
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        2     -none- numeric
fitted.values     44     ts     numeric
errors            44     ts     numeric
x                 88     -none- numeric
seasonal.periods   0     -none- NULL
y                 44     ts     numeric
call               2     -none- call
series             1     -none- character
method             1     -none- character

Forecasts for Time Series ID: 1054
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7692.103 7809.855 7928.196 8047.124
1992 8166.635 8286.727 8407.397 8528.642

Summary for TBATS model of Time Series ID: 1055
                  Length Class  Mode
lambda             1     -none- numeric
alpha              1     -none- numeric
beta               1     -none- numeric
damping.parameter  1     -none- numeric
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
```

```
variance          1      -none- numeric
AIC               1      -none- numeric
parameters        2      -none- list
seed.states       2      -none- numeric
fitted.values    44      ts     numeric
errors           44      ts     numeric
x                88      -none- numeric
seasonal.periods  0      -none- NULL
y                44      ts     numeric
call              2      -none- call
series            1      -none- character
method            1      -none- character

Forecasts for Time Series ID: 1055
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6624.748 6744.717 6866.741 6990.854
1992 7117.090 7245.482 7376.065 7508.875

Summary for TBATS model of Time Series ID: 1056
                  Length Class  Mode
lambda            1      -none- numeric
alpha             1      -none- numeric
beta              1      -none- numeric
damping.parameter 1      -none- numeric
gamma.values      0      -none- NULL
ar.coefficients   0      -none- NULL
ma.coefficients   0      -none- NULL
likelihood        1      -none- numeric
optim.return.code 1      -none- numeric
variance          1      -none- numeric
```

```
AIC                 1     -none- numeric
parameters          2     -none- list
seed.states         2     -none- numeric
fitted.values      44     ts     numeric
errors             44     ts     numeric
x                  88     -none- numeric
seasonal.periods    0     -none- NULL
y                  44     ts     numeric
call                2     -none- call
series              1     -none- character
method              1     -none- character

Forecasts for Time Series ID: 1056
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5911.252 5833.384 5771.815 5723.020
1992 5684.275 5653.465 5628.935 5609.386

Summary for TBATS model of Time Series ID: 1057
                  Length Class  Mode
lambda              0     -none- NULL
alpha               1     -none- numeric
beta                1     -none- numeric
damping.parameter   1     -none- numeric
gamma.values        0     -none- NULL
ar.coefficients     0     -none- NULL
ma.coefficients     0     -none- NULL
likelihood          1     -none- numeric
optim.return.code   1     -none- numeric
variance            1     -none- numeric
AIC                 1     -none- numeric
```

```
parameters         2      -none- list
seed.states        2      -none- numeric
fitted.values     44      ts     numeric
errors            44      ts     numeric
x                 88      -none- numeric
seasonal.periods   0      -none- NULL
y                 44      ts     numeric
call               2      -none- call
series             1      -none- character
method             1      -none- character
```

```
Forecasts for Time Series ID: 1057
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7960.137 8031.037 8101.937 8172.838
1992 8243.738 8314.638 8385.539 8456.439
```

```
Summary for TBATS model of Time Series ID: 1058
                  Length Class  Mode
lambda             0      -none- NULL
alpha              1      -none- numeric
beta               0      -none- NULL
damping.parameter  0      -none- NULL
gamma.values       0      -none- NULL
ar.coefficients    0      -none- NULL
ma.coefficients    0      -none- NULL
likelihood         1      -none- numeric
optim.return.code  1      -none- numeric
variance           1      -none- numeric
AIC                1      -none- numeric
parameters         2      -none- list
```

```
seed.states        1     -none- numeric
fitted.values     44     ts     numeric
errors            44     ts     numeric
x                 44     -none- numeric
seasonal.periods   0     -none- NULL
y                 44     ts     numeric
call               2     -none- call
series             1     -none- character
method             1     -none- character

Forecasts for Time Series ID: 1058
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4036.701 4036.701 4036.701 4036.701
1992 4036.701 4036.701 4036.701 4036.701

Summary for TBATS model of Time Series ID: 1059
                  Length Class  Mode
lambda             0     -none- NULL
alpha              1     -none- numeric
beta               0     -none- NULL
damping.parameter  0     -none- NULL
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        1     -none- numeric
```

```
fitted.values     44     ts     numeric
errors            44     ts     numeric
x                 44     -none- numeric
seasonal.periods   0     -none- NULL
y                 44     ts     numeric
call               2     -none- call
series             1     -none- character
method             1     -none- character

Forecasts for Time Series ID: 1059
         Qtr1     Qtr2     Qtr3     Qtr4
1991 3726.979 3726.979 3726.979 3726.979
1992 3726.979 3726.979 3726.979 3726.979

Summary for TBATS model of Time Series ID: 1060
                  Length Class  Mode
lambda             0     -none- NULL
alpha              1     -none- numeric
beta               0     -none- NULL
damping.parameter  0     -none- NULL
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        1     -none- numeric
fitted.values     44     ts     numeric
```

```
errors             44     ts     numeric
x                  44     -none- numeric
seasonal.periods    0     -none- NULL
y                  44     ts     numeric
call                2     -none- call
series              1     -none- character
method              1     -none- character
```

```
Forecasts for Time Series ID: 1060
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4115.292 4115.292 4115.292 4115.292
1992 4115.292 4115.292 4115.292 4115.292
```

```
Summary for TBATS model of Time Series ID: 1061
                  Length Class  Mode
lambda             0     -none- NULL
alpha              1     -none- numeric
beta               0     -none- NULL
damping.parameter  0     -none- NULL
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        1     -none- numeric
fitted.values     44     ts     numeric
errors            44     ts     numeric
```

```
x                  44     -none- numeric
seasonal.periods    0     -none- NULL
y                  44     ts     numeric
call                2     -none- call
series              1     -none- character
method              1     -none- character

Forecasts for Time Series ID: 1061
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4194.267 4194.267 4194.267 4194.267
1992 4194.267 4194.267 4194.267 4194.267

Summary for TBATS model of Time Series ID: 1062
                  Length Class  Mode
lambda             0     -none- NULL
alpha              1     -none- numeric
beta               0     -none- NULL
damping.parameter  0     -none- NULL
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        1     -none- numeric
fitted.values     44     ts     numeric
errors            44     ts     numeric
x                 44     -none- numeric
```

```
seasonal.periods   0     -none- NULL
y                 44     ts     numeric
call               2     -none- call
series             1     -none- character
method             1     -none- character

Forecasts for Time Series ID: 1062
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7399.993 7399.993 7399.993 7399.993
1992 7399.993 7399.993 7399.993 7399.993

Summary for TBATS model of Time Series ID: 1063
                  Length Class  Mode
lambda             0     -none- NULL
alpha              1     -none- numeric
beta               0     -none- NULL
damping.parameter  0     -none- NULL
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        1     -none- numeric
fitted.values     44     ts     numeric
errors            44     ts     numeric
x                 44     -none- numeric
seasonal.periods   0     -none- NULL
```

```
y                 44     ts     numeric
call               2     -none- call
series             1     -none- character
method             1     -none- character

Forecasts for Time Series ID: 1063
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6371.639 6371.639 6371.639 6371.639
1992 6371.639 6371.639 6371.639 6371.639

Summary for TBATS model of Time Series ID: 1064
                  Length Class  Mode
lambda             1     -none- numeric
alpha              1     -none- numeric
beta               0     -none- NULL
damping.parameter  0     -none- NULL
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        1     -none- numeric
fitted.values     44     ts     numeric
errors            44     ts     numeric
x                 44     -none- numeric
seasonal.periods   0     -none- NULL
y                 44     ts     numeric
```

```
call               2     -none- call
series             1     -none- character
method             1     -none- character

Forecasts for Time Series ID: 1064
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6996.397 6996.397 6996.397 6996.397
1992 6996.397 6996.397 6996.397 6996.397

Summary for TBATS model of Time Series ID: 1065
                  Length Class  Mode
lambda             0     -none- NULL
alpha              1     -none- numeric
beta               0     -none- NULL
damping.parameter  0     -none- NULL
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        1     -none- numeric
fitted.values     44     ts     numeric
errors            44     ts     numeric
x                 44     -none- numeric
seasonal.periods   0     -none- NULL
y                 44     ts     numeric
call               2     -none- call
```

```
series             1     -none- character
method             1     -none- character

Forecasts for Time Series ID: 1065
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7816.674 7816.674 7816.674 7816.674
1992 7816.674 7816.674 7816.674 7816.674

Summary for TBATS model of Time Series ID: 1066
                  Length Class  Mode
lambda             1     -none- numeric
alpha              1     -none- numeric
beta               1     -none- numeric
damping.parameter  1     -none- numeric
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        2     -none- numeric
fitted.values     44     ts     numeric
errors            44     ts     numeric
x                 88     -none- numeric
seasonal.periods   0     -none- NULL
y                 44     ts     numeric
call               2     -none- call
series             1     -none- character
```

```
method             1      -none- character

Forecasts for Time Series ID: 1066
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6067.446 6175.040 6283.599 6393.122
1992 6503.611 6615.066 6727.487 6840.874

Summary for TBATS model of Time Series ID: 1067
                  Length Class  Mode
lambda             1     -none- numeric
alpha              1     -none- numeric
beta               1     -none- numeric
damping.parameter  1     -none- numeric
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        2     -none- numeric
fitted.values     44     ts     numeric
errors            44     ts     numeric
x                 88     -none- numeric
seasonal.periods   0     -none- NULL
y                 44     ts     numeric
call               2     -none- call
series             1     -none- character
method             1     -none- character
```

```
Forecasts for Time Series ID: 1067
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6397.048 6431.016 6465.162 6499.489
1992 6533.996 6568.686 6603.558 6638.614
```

```
Summary for TBATS model of Time Series ID: 1068
                  Length Class  Mode
lambda             1     -none- numeric
alpha              1     -none- numeric
beta               1     -none- numeric
damping.parameter  1     -none- numeric
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        2     -none- numeric
fitted.values     44     ts     numeric
errors            44     ts     numeric
x                 88     -none- numeric
seasonal.periods   0     -none- NULL
y                 44     ts     numeric
call               2     -none- call
series             1     -none- character
method             1     -none- character
```

```
Forecasts for Time Series ID: 1068

          Qtr1      Qtr2      Qtr3      Qtr4
1991  9004.831  9210.121  9418.864  9631.100
1992  9846.866 10066.200 10289.140 10515.726


Summary for TBATS model of Time Series ID: 1069
                  Length Class  Mode
lambda             0     -none- NULL
alpha              1     -none- numeric
beta               1     -none- numeric
damping.parameter  1     -none- numeric
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        2     -none- numeric
fitted.values     44     ts     numeric
errors            44     ts     numeric
x                 88     -none- numeric
seasonal.periods   0     -none- NULL
y                 44     ts     numeric
call               2     -none- call
series             1     -none- character
method             1     -none- character


Forecasts for Time Series ID: 1069
```

```
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7297.530 7407.901 7518.272 7628.643
1992 7739.015 7849.386 7959.757 8070.129

Summary for TBATS model of Time Series ID: 1070
                  Length Class  Mode
lambda             1     -none- numeric
alpha              1     -none- numeric
beta               1     -none- numeric
damping.parameter  1     -none- numeric
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        2     -none- numeric
fitted.values     44     ts     numeric
errors            44     ts     numeric
x                 88     -none- numeric
seasonal.periods   0     -none- NULL
y                 44     ts     numeric
call               2     -none- call
series             1     -none- character
method             1     -none- character

Forecasts for Time Series ID: 1070
          Qtr1      Qtr2      Qtr3      Qtr4
```

```
1991  9103.709  9317.681  9534.758  9754.960
1992  9978.303 10204.804 10434.482 10667.354
```

```
Summary for TBATS model of Time Series ID: 1071
                  Length Class  Mode
lambda             0     -none- NULL
alpha              1     -none- numeric
beta               1     -none- numeric
damping.parameter  1     -none- numeric
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        2     -none- numeric
fitted.values     26     ts     numeric
errors            26     ts     numeric
x                 52     -none- numeric
seasonal.periods   0     -none- NULL
y                 26     ts     numeric
call               2     -none- call
series             1     -none- character
method             1     -none- character
```

```
Forecasts for Time Series ID: 1071
         Qtr1     Qtr2     Qtr3     Qtr4
1992                   5755.802 5777.295
```

```
1993 5798.787 5820.280 5841.772 5863.265
1994 5884.757 5906.250
```

Summary for TBATS model of Time Series ID: 1072

```
                  Length Class  Mode
lambda             0     -none- NULL
alpha              1     -none- numeric
beta               0     -none- NULL
damping.parameter  0     -none- NULL
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        1     -none- numeric
fitted.values     26     ts     numeric
errors            26     ts     numeric
x                 26     -none- numeric
seasonal.periods   0     -none- NULL
y                 26     ts     numeric
call               2     -none- call
series             1     -none- character
method             1     -none- character
```

Forecasts for Time Series ID: 1072

```
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6165.575 6165.575 6165.575 6165.575
```

```
1992 6165.575 6165.575 6165.575 6165.575
```

```
Summary for TBATS model of Time Series ID: 1073
                  Length Class  Mode
lambda             0     -none- NULL
alpha              1     -none- numeric
beta               1     -none- numeric
damping.parameter  1     -none- numeric
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        2     -none- numeric
fitted.values     26     ts     numeric
errors            26     ts     numeric
x                 52     -none- numeric
seasonal.periods   0     -none- NULL
y                 26     ts     numeric
call               2     -none- call
series             1     -none- character
method             1     -none- character
```

```
Forecasts for Time Series ID: 1073
         Qtr1     Qtr2     Qtr3     Qtr4
1991 8142.181 8197.062 8251.944 8306.825
1992 8361.706 8416.588 8471.469 8526.351
```

```
Summary for TBATS model of Time Series ID: 1074
                  Length Class  Mode
lambda             0     -none- NULL
alpha              1     -none- numeric
beta               1     -none- numeric
damping.parameter  1     -none- numeric
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        2     -none- numeric
fitted.values     26     ts     numeric
errors            26     ts     numeric
x                 52     -none- numeric
seasonal.periods   0     -none- NULL
y                 26     ts     numeric
call               2     -none- call
series             1     -none- character
method             1     -none- character

Forecasts for Time Series ID: 1074
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7092.660 7103.209 7113.757 7124.306
1992 7134.855 7145.403 7155.952 7166.500
```

Summary for TBATS model of Time Series ID: 1075

```
                  Length Class  Mode
lambda             0     -none- NULL
alpha              1     -none- numeric
beta               1     -none- numeric
damping.parameter  1     -none- numeric
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        2     -none- numeric
fitted.values     26     ts     numeric
errors            26     ts     numeric
x                 52     -none- numeric
seasonal.periods   0     -none- NULL
y                 26     ts     numeric
call               2     -none- call
series             1     -none- character
method             1     -none- character
```

Forecasts for Time Series ID: 1075

```
         Qtr1     Qtr2     Qtr3     Qtr4
1991 8377.703 8347.461 8319.997 8295.054
1992 8272.401 8251.828 8233.145 8216.177
```

Summary for TBATS model of Time Series ID: 1076

```
                  Length Class  Mode
lambda             0     -none- NULL
alpha              1     -none- numeric
beta               1     -none- numeric
damping.parameter  1     -none- numeric
gamma.values       0     -none- NULL
ar.coefficients    0     -none- NULL
ma.coefficients    0     -none- NULL
likelihood         1     -none- numeric
optim.return.code  1     -none- numeric
variance           1     -none- numeric
AIC                1     -none- numeric
parameters         2     -none- list
seed.states        2     -none- numeric
fitted.values     44     ts     numeric
errors            44     ts     numeric
x                 88     -none- numeric
seasonal.periods   0     -none- NULL
y                 44     ts     numeric
call               2     -none- call
series             1     -none- character
method             1     -none- character

Forecasts for Time Series ID: 1076
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5449.988 5483.215 5516.442 5549.669
1992 5582.896 5616.123 5649.350 5682.577

Summary for TBATS model of Time Series ID: 1077
                  Length Class  Mode
```

```
lambda               1    -none- numeric
alpha                1    -none- numeric
beta                 1    -none- numeric
damping.parameter    1    -none- numeric
gamma.one.values     1    -none- numeric
gamma.two.values     1    -none- numeric
ar.coefficients      3    -none- numeric
ma.coefficients      0    -none- NULL
likelihood           1    -none- numeric
optim.return.code    1    -none- numeric
variance             1    -none- numeric
AIC                  1    -none- numeric
parameters           2    -none- list
seed.states          7    -none- numeric
fitted.values       44    ts     numeric
errors              44    ts     numeric
x                  308    -none- numeric
seasonal.periods     1    -none- numeric
k.vector             1    -none- numeric
y                   44    ts     numeric
p                    1    -none- numeric
q                    1    -none- numeric
call                 2    -none- call
series               1    -none- character
method               1    -none- character

Forecasts for Time Series ID: 1077
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4871.621 5233.788 5391.760 5888.971
1992 5222.137 5576.770 5754.971 6264.671
```

Summary for TBATS model of Time Series ID: 1078

```
                  Length Class  Mode
lambda              0    -none- NULL
alpha               1    -none- numeric
beta                1    -none- numeric
damping.parameter   1    -none- numeric
gamma.one.values    1    -none- numeric
gamma.two.values    1    -none- numeric
ar.coefficients     2    -none- numeric
ma.coefficients     0    -none- NULL
likelihood          1    -none- numeric
optim.return.code   1    -none- numeric
variance            1    -none- numeric
AIC                 1    -none- numeric
parameters          2    -none- list
seed.states         6    -none- numeric
fitted.values      44    ts     numeric
errors             44    ts     numeric
x                 264    -none- numeric
seasonal.periods    1    -none- numeric
k.vector            1    -none- numeric
y                  44    ts     numeric
p                   1    -none- numeric
q                   1    -none- numeric
call                2    -none- call
series              1    -none- character
method              1    -none- character
```

Forecasts for Time Series ID: 1078

```
         Qtr1     Qtr2     Qtr3     Qtr4
1991 8639.363 8191.158 8415.513 8202.764
1992 9006.115 8579.445 8785.723 8594.005

Summary for TBATS model of Time Series ID: 1079
                  Length Class  Mode
lambda              1    -none- numeric
alpha               1    -none- numeric
beta                1    -none- numeric
damping.parameter   1    -none- numeric
gamma.one.values    1    -none- numeric
gamma.two.values    1    -none- numeric
ar.coefficients     3    -none- numeric
ma.coefficients     0    -none- NULL
likelihood          1    -none- numeric
optim.return.code   1    -none- numeric
variance            1    -none- numeric
AIC                 1    -none- numeric
parameters          2    -none- list
seed.states         7    -none- numeric
fitted.values      44    ts     numeric
errors             44    ts     numeric
x                 308    -none- numeric
seasonal.periods    1    -none- numeric
k.vector            1    -none- numeric
y                  44    ts     numeric
p                   1    -none- numeric
q                   1    -none- numeric
call                2    -none- call
series              1    -none- character
```

```
method              1    -none- character

Forecasts for Time Series ID: 1079
         Qtr1     Qtr2     Qtr3     Qtr4
1991 3999.341 6094.920 6921.117 6902.875
1992 4367.765 6598.574 7541.595 7463.236

Summary for TBATS model of Time Series ID: 1080
                  Length Class  Mode
lambda              0    -none- NULL
alpha               1    -none- numeric
beta                1    -none- numeric
damping.parameter   1    -none- numeric
gamma.one.values    1    -none- numeric
gamma.two.values    1    -none- numeric
ar.coefficients     3    -none- numeric
ma.coefficients     0    -none- NULL
likelihood          1    -none- numeric
optim.return.code   1    -none- numeric
variance            1    -none- numeric
AIC                 1    -none- numeric
parameters          2    -none- list
seed.states         7    -none- numeric
fitted.values      44    ts     numeric
errors             44    ts     numeric
x                 308    -none- numeric
seasonal.periods    1    -none- numeric
k.vector            1    -none- numeric
y                  44    ts     numeric
p                   1    -none- numeric
```

```
q                  1    -none- numeric
call               2    -none- call
series             1    -none- character
method             1    -none- character

Forecasts for Time Series ID: 1080
         Qtr1     Qtr2     Qtr3     Qtr4
1991 3810.199 3927.520 4166.715 4175.956
1992 4329.984 4511.202 4783.590 4844.752

Summary for TBATS model of Time Series ID: 1081
                  Length Class  Mode
lambda              1    -none- numeric
alpha               1    -none- numeric
beta                1    -none- numeric
damping.parameter   1    -none- numeric
gamma.one.values    1    -none- numeric
gamma.two.values    1    -none- numeric
ar.coefficients     0    -none- NULL
ma.coefficients     0    -none- NULL
likelihood          1    -none- numeric
optim.return.code   1    -none- numeric
variance            1    -none- numeric
AIC                 1    -none- numeric
parameters          2    -none- list
seed.states         4    -none- numeric
fitted.values      44    ts     numeric
errors             44    ts     numeric
x                 176    -none- numeric
seasonal.periods    1    -none- numeric
```

```
k.vector            1    -none- numeric
y                  44    ts     numeric
p                   1    -none- numeric
q                   1    -none- numeric
call                2    -none- call
series              1    -none- character
method              1    -none- character

Forecasts for Time Series ID: 1081
         Qtr1     Qtr2     Qtr3     Qtr4
1991 3585.769 3752.103 3919.331 3845.742
1992 3775.997 3946.961 4118.749 4043.164

Summary for TBATS model of Time Series ID: 1082
                  Length Class  Mode
lambda              1    -none- numeric
alpha               1    -none- numeric
beta                1    -none- numeric
damping.parameter   1    -none- numeric
gamma.one.values    1    -none- numeric
gamma.two.values    1    -none- numeric
ar.coefficients     3    -none- numeric
ma.coefficients     0    -none- NULL
likelihood          1    -none- numeric
optim.return.code   1    -none- numeric
variance            1    -none- numeric
AIC                 1    -none- numeric
parameters          2    -none- list
seed.states         7    -none- numeric
fitted.values      44    ts     numeric
```

```
errors             44    ts     numeric
x                 308    -none- numeric
seasonal.periods    1    -none- numeric
k.vector            1    -none- numeric
y                  44    ts     numeric
p                   1    -none- numeric
q                   1    -none- numeric
call                2    -none- call
series              1    -none- character
method              1    -none- character

Forecasts for Time Series ID: 1082
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4416.318 4728.525 4990.714 5226.756
1992 4786.660 5103.624 5383.298 5622.909

Summary for TBATS model of Time Series ID: 1083
                  Length Class  Mode
lambda              1    -none- numeric
alpha               1    -none- numeric
beta                1    -none- numeric
damping.parameter   1    -none- numeric
gamma.one.values    1    -none- numeric
gamma.two.values    1    -none- numeric
ar.coefficients     3    -none- numeric
ma.coefficients     0    -none- NULL
likelihood          1    -none- numeric
optim.return.code   1    -none- numeric
variance            1    -none- numeric
AIC                 1    -none- numeric
```

```
parameters          2    -none- list
seed.states         7    -none- numeric
fitted.values      44    ts     numeric
errors             44    ts     numeric
x                 308    -none- numeric
seasonal.periods    1    -none- numeric
k.vector            1    -none- numeric
y                  44    ts     numeric
p                   1    -none- numeric
q                   1    -none- numeric
call                2    -none- call
series              1    -none- character
method              1    -none- character

Forecasts for Time Series ID: 1083
         Qtr1     Qtr2     Qtr3     Qtr4
1991 3933.468 4189.520 4417.470 4817.803
1992 4180.502 4421.628 4654.533 5048.703

Summary for TBATS model of Time Series ID: 1084
                  Length Class  Mode
lambda              1    -none- numeric
alpha               1    -none- numeric
beta                1    -none- numeric
damping.parameter   1    -none- numeric
gamma.one.values    1    -none- numeric
gamma.two.values    1    -none- numeric
ar.coefficients     0    -none- NULL
ma.coefficients     0    -none- NULL
likelihood          1    -none- numeric
```

```
optim.return.code   1    -none- numeric
variance            1    -none- numeric
AIC                 1    -none- numeric
parameters          2    -none- list
seed.states         4    -none- numeric
fitted.values      44    ts     numeric
errors             44    ts     numeric
x                 176    -none- numeric
seasonal.periods    1    -none- numeric
k.vector            1    -none- numeric
y                  44    ts     numeric
p                   1    -none- numeric
q                   1    -none- numeric
call                2    -none- call
series              1    -none- character
method              1    -none- character
```

```
Forecasts for Time Series ID: 1084
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6085.388 6096.665 6151.292 6159.338
1992 6123.428 6133.733 6187.669 6194.767
```

```
Summary for TBATS model of Time Series ID: 1085
                  Length Class  Mode
lambda              0    -none- NULL
alpha               1    -none- numeric
beta                0    -none- NULL
damping.parameter   0    -none- NULL
gamma.one.values    1    -none- numeric
gamma.two.values    1    -none- numeric
```

```
ar.coefficients     2    -none- numeric
ma.coefficients     0    -none- NULL
likelihood          1    -none- numeric
optim.return.code   1    -none- numeric
variance            1    -none- numeric
AIC                 1    -none- numeric
parameters          2    -none- list
seed.states         5    -none- numeric
fitted.values      44    ts     numeric
errors             44    ts     numeric
x                 220    -none- numeric
seasonal.periods    1    -none- numeric
k.vector            1    -none- numeric
y                  44    ts     numeric
p                   1    -none- numeric
q                   1    -none- numeric
call                2    -none- call
series              1    -none- character
method              1    -none- character

Forecasts for Time Series ID: 1085
         Qtr1     Qtr2     Qtr3     Qtr4
1991 3660.583 4931.238 5509.993 5506.931
1992 3924.666 5170.168 5768.871 5741.156

Summary for TBATS model of Time Series ID: 1086
                  Length Class  Mode
lambda              0    -none- NULL
alpha               1    -none- numeric
beta                1    -none- numeric
```

```
damping.parameter   1    -none- numeric
gamma.one.values    1    -none- numeric
gamma.two.values    1    -none- numeric
ar.coefficients     2    -none- numeric
ma.coefficients     1    -none- numeric
likelihood          1    -none- numeric
optim.return.code   1    -none- numeric
variance            1    -none- numeric
AIC                 1    -none- numeric
parameters          2    -none- list
seed.states         7    -none- numeric
fitted.values      44    ts     numeric
errors             44    ts     numeric
x                 308    -none- numeric
seasonal.periods    1    -none- numeric
k.vector            1    -none- numeric
y                  44    ts     numeric
p                   1    -none- numeric
q                   1    -none- numeric
call                2    -none- call
series              1    -none- character
method              1    -none- character

Forecasts for Time Series ID: 1086
         Qtr1     Qtr2     Qtr3     Qtr4
1991 8407.512 8692.011 9022.769 8837.086
1992 8743.720 9029.053 9346.274 9161.156

Summary for TBATS model of Time Series ID: 1087
                  Length Class  Mode
```

```
lambda              1    -none- numeric
alpha               1    -none- numeric
beta                1    -none- numeric
damping.parameter   1    -none- numeric
gamma.one.values    1    -none- numeric
gamma.two.values    1    -none- numeric
ar.coefficients     1    -none- numeric
ma.coefficients     2    -none- numeric
likelihood          1    -none- numeric
optim.return.code   1    -none- numeric
variance            1    -none- numeric
AIC                 1    -none- numeric
parameters          2    -none- list
seed.states         7    -none- numeric
fitted.values      44    ts     numeric
errors             44    ts     numeric
x                 308    -none- numeric
seasonal.periods    1    -none- numeric
k.vector            1    -none- numeric
y                  44    ts     numeric
p                   1    -none- numeric
q                   1    -none- numeric
call                2    -none- call
series              1    -none- character
method              1    -none- character

Forecasts for Time Series ID: 1087
         Qtr1     Qtr2     Qtr3     Qtr4
1991 3352.503 3635.732 3709.391 3823.620
1992 3581.026 3912.837 3998.572 4115.010
```

```
Summary for TBATS model of Time Series ID: 1088
                  Length Class  Mode
lambda              0    -none- NULL
alpha               1    -none- numeric
beta                1    -none- numeric
damping.parameter   1    -none- numeric
gamma.one.values    1    -none- numeric
gamma.two.values    1    -none- numeric
ar.coefficients     3    -none- numeric
ma.coefficients     0    -none- NULL
likelihood          1    -none- numeric
optim.return.code   1    -none- numeric
variance            1    -none- numeric
AIC                 1    -none- numeric
parameters          2    -none- list
seed.states         7    -none- numeric
fitted.values      44    ts     numeric
errors             44    ts     numeric
x                 308    -none- numeric
seasonal.periods    1    -none- numeric
k.vector            1    -none- numeric
y                  44    ts     numeric
p                   1    -none- numeric
q                   1    -none- numeric
call                2    -none- call
series              1    -none- character
method              1    -none- character

Forecasts for Time Series ID: 1088
```

```
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6911.932 7423.467 7751.342 8056.950
1992 7225.932 7703.242 8066.903 8341.466

Summary for TBATS model of Time Series ID: 1089
                  Length Class  Mode
lambda              0    -none- NULL
alpha               1    -none- numeric
beta                1    -none- numeric
damping.parameter   1    -none- numeric
gamma.one.values    1    -none- numeric
gamma.two.values    1    -none- numeric
ar.coefficients     1    -none- numeric
ma.coefficients     2    -none- numeric
likelihood          1    -none- numeric
optim.return.code   1    -none- numeric
variance            1    -none- numeric
AIC                 1    -none- numeric
parameters          2    -none- list
seed.states         7    -none- numeric
fitted.values      44    ts     numeric
errors             44    ts     numeric
x                 308    -none- numeric
seasonal.periods    1    -none- numeric
k.vector            1    -none- numeric
y                  44    ts     numeric
p                   1    -none- numeric
q                   1    -none- numeric
call                2    -none- call
series              1    -none- character
```

```
method              1    -none- character
```

```
Forecasts for Time Series ID: 1089
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6155.309 6196.038 6131.229 6147.533
1992 6238.615 6278.672 6212.622 6225.861
```

```
Summary for TBATS model of Time Series ID: 1090
                  Length Class  Mode
lambda              1    -none- numeric
alpha               1    -none- numeric
beta                1    -none- numeric
damping.parameter   1    -none- numeric
gamma.one.values    1    -none- numeric
gamma.two.values    1    -none- numeric
ar.coefficients     2    -none- numeric
ma.coefficients     0    -none- NULL
likelihood          1    -none- numeric
optim.return.code   1    -none- numeric
variance            1    -none- numeric
AIC                 1    -none- numeric
parameters          2    -none- list
seed.states         6    -none- numeric
fitted.values      44    ts     numeric
errors             44    ts     numeric
x                 264    -none- numeric
seasonal.periods    1    -none- numeric
k.vector            1    -none- numeric
y                  44    ts     numeric
p                   1    -none- numeric
```

```
q                    1    -none- numeric
call                 2    -none- call
series               1    -none- character
method               1    -none- character

Forecasts for Time Series ID: 1090
         Qtr1     Qtr2     Qtr3     Qtr4
1991 7173.648 6633.571 6791.136 6510.086
1992 7363.966 6837.848 6967.179 6705.098

Summary for TBATS model of Time Series ID: 1091
                  Length Class  Mode
lambda               0    -none- NULL
alpha                1    -none- numeric
beta                 1    -none- numeric
damping.parameter    1    -none- numeric
gamma.one.values     1    -none- numeric
gamma.two.values     1    -none- numeric
ar.coefficients      0    -none- NULL
ma.coefficients      0    -none- NULL
likelihood           1    -none- numeric
optim.return.code    1    -none- numeric
variance             1    -none- numeric
AIC                  1    -none- numeric
parameters           2    -none- list
seed.states          4    -none- numeric
fitted.values       44    ts     numeric
errors              44    ts     numeric
x                  176    -none- numeric
seasonal.periods     1    -none- numeric
```

```
k.vector             1    -none- numeric
y                   44    ts     numeric
p                    1    -none- numeric
q                    1    -none- numeric
call                 2    -none- call
series               1    -none- character
method               1    -none- character
```

Forecasts for Time Series ID: 1091

```
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6110.406 6222.704 6214.944 6185.332
1992 6273.725 6381.972 6370.263 6336.798
```

Summary for TBATS model of Time Series ID: 1092

```
                  Length Class  Mode
lambda               0    -none- NULL
alpha                1    -none- numeric
beta                 1    -none- numeric
damping.parameter    1    -none- numeric
gamma.one.values     1    -none- numeric
gamma.two.values     1    -none- numeric
ar.coefficients      2    -none- numeric
ma.coefficients      1    -none- numeric
likelihood           1    -none- numeric
optim.return.code    1    -none- numeric
variance             1    -none- numeric
AIC                  1    -none- numeric
parameters           2    -none- list
seed.states          7    -none- numeric
fitted.values       44    ts     numeric
```

```
errors             44    ts     numeric
x                 308    -none- numeric
seasonal.periods    1    -none- numeric
k.vector            1    -none- numeric
y                  44    ts     numeric
p                   1    -none- numeric
q                   1    -none- numeric
call                2    -none- call
series              1    -none- character
method              1    -none- character
```

```
Forecasts for Time Series ID: 1092
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5604.653 5458.348 5506.747 5460.126
1992 5622.827 5479.337 5522.680 5479.038
```

```
Summary for TBATS model of Time Series ID: 1093
                  Length Class  Mode
lambda              1    -none- numeric
alpha               1    -none- numeric
beta                1    -none- numeric
damping.parameter   1    -none- numeric
gamma.values        0    -none- NULL
ar.coefficients     1    -none- numeric
ma.coefficients     2    -none- numeric
likelihood          1    -none- numeric
optim.return.code   1    -none- numeric
variance            1    -none- numeric
AIC                 1    -none- numeric
parameters          2    -none- list
```

```
seed.states          5    -none- numeric
fitted.values       44    ts     numeric
errors              44    ts     numeric
x                  220    -none- numeric
seasonal.periods     0    -none- NULL
y                   44    ts     numeric
call                 2    -none- call
series               1    -none- character
method               1    -none- character

Forecasts for Time Series ID: 1093
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5320.757 5178.386 5341.203 5202.955
1992 5363.507 5227.612 5385.934 5252.356

Summary for TBATS model of Time Series ID: 1094
                  Length Class  Mode
lambda               0    -none- NULL
alpha                1    -none- numeric
beta                 1    -none- numeric
damping.parameter    1    -none- numeric
gamma.one.values     1    -none- numeric
gamma.two.values     1    -none- numeric
ar.coefficients      0    -none- NULL
ma.coefficients      0    -none- NULL
likelihood           1    -none- numeric
optim.return.code    1    -none- numeric
variance             1    -none- numeric
AIC                  1    -none- numeric
parameters           2    -none- list
```

```
seed.states          4    -none- numeric
fitted.values       44    ts     numeric
errors              44    ts     numeric
x                  176    -none- numeric
seasonal.periods     1    -none- numeric
k.vector             1    -none- numeric
y                   44    ts     numeric
p                    1    -none- numeric
q                    1    -none- numeric
call                 2    -none- call
series               1    -none- character
method               1    -none- character

Forecasts for Time Series ID: 1094
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6347.357 6341.503 6252.951 6320.014
1992 6468.718 6460.767 6370.155 6435.194

Summary for TBATS model of Time Series ID: 1095
                  Length Class  Mode
lambda               0    -none- NULL
alpha                1    -none- numeric
beta                 1    -none- numeric
damping.parameter    1    -none- numeric
gamma.one.values     1    -none- numeric
gamma.two.values     1    -none- numeric
ar.coefficients      1    -none- numeric
ma.coefficients      0    -none- NULL
likelihood           1    -none- numeric
optim.return.code    1    -none- numeric
```

```
variance            1    -none- numeric
AIC                 1    -none- numeric
parameters          2    -none- list
seed.states         5    -none- numeric
fitted.values      44    ts     numeric
errors             44    ts     numeric
x                 220    -none- numeric
seasonal.periods    1    -none- numeric
k.vector            1    -none- numeric
y                  44    ts     numeric
p                   1    -none- numeric
q                   1    -none- numeric
call                2    -none- call
series              1    -none- character
method              1    -none- character

Forecasts for Time Series ID: 1095
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4704.391 5148.341 4886.704 5386.580
1992 5030.803 5459.295 5212.963 5697.686

Summary for TBATS model of Time Series ID: 1096
                  Length Class  Mode
lambda              1    -none- numeric
alpha               1    -none- numeric
beta                0    -none- NULL
damping.parameter   0    -none- NULL
gamma.one.values    1    -none- numeric
gamma.two.values    1    -none- numeric
ar.coefficients     2    -none- numeric
```

```
ma.coefficients     0    -none- NULL
likelihood          1    -none- numeric
optim.return.code   1    -none- numeric
variance            1    -none- numeric
AIC                 1    -none- numeric
parameters          2    -none- list
seed.states         5    -none- numeric
fitted.values      44    ts     numeric
errors             44    ts     numeric
x                 220    -none- numeric
seasonal.periods    1    -none- numeric
k.vector            1    -none- numeric
y                  44    ts     numeric
p                   1    -none- numeric
q                   1    -none- numeric
call                2    -none- call
series              1    -none- character
method              1    -none- character

Forecasts for Time Series ID: 1096
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4422.296 4500.155 6287.833 5656.236
1992 4586.567 4792.695 6472.086 5934.665

Summary for TBATS model of Time Series ID: 1097
                  Length Class  Mode
lambda              1    -none- numeric
alpha               1    -none- numeric
beta                1    -none- numeric
damping.parameter   1    -none- numeric
```

```
gamma.one.values    1    -none- numeric
gamma.two.values    1    -none- numeric
ar.coefficients     4    -none- numeric
ma.coefficients     0    -none- NULL
likelihood          1    -none- numeric
optim.return.code   1    -none- numeric
variance            1    -none- numeric
AIC                 1    -none- numeric
parameters          2    -none- list
seed.states         8    -none- numeric
fitted.values      44    ts     numeric
errors             44    ts     numeric
x                 352    -none- numeric
seasonal.periods    1    -none- numeric
k.vector            1    -none- numeric
y                  44    ts     numeric
p                   1    -none- numeric
q                   1    -none- numeric
call                2    -none- call
series              1    -none- character
method              1    -none- character

Forecasts for Time Series ID: 1097
         Qtr1     Qtr2     Qtr3     Qtr4
1991 5500.702 5799.474 5892.073 5898.472
1992 5795.835 6092.514 6181.815 6182.116

Summary for TBATS model of Time Series ID: 1098
                  Length Class  Mode
lambda              0    -none- NULL
```

```
alpha                 1    -none- numeric
beta                  1    -none- numeric
damping.parameter     1    -none- numeric
gamma.one.values      1    -none- numeric
gamma.two.values      1    -none- numeric
ar.coefficients       2    -none- numeric
ma.coefficients       0    -none- NULL
likelihood            1    -none- numeric
optim.return.code     1    -none- numeric
variance              1    -none- numeric
AIC                   1    -none- numeric
parameters            2    -none- list
seed.states           6    -none- numeric
fitted.values        44    ts     numeric
errors               44    ts     numeric
x                   264    -none- numeric
seasonal.periods      1    -none- numeric
k.vector              1    -none- numeric
y                    44    ts     numeric
p                     1    -none- numeric
q                     1    -none- numeric
call                  2    -none- call
series                1    -none- character
method                1    -none- character

Forecasts for Time Series ID: 1098
         Qtr1     Qtr2     Qtr3     Qtr4
1991 6105.887 6313.083 6226.140 6880.892
1992 6418.057 6602.768 6531.745 7172.349
```

```
Summary for TBATS model of Time Series ID: 1099
                  Length Class  Mode
lambda              1    -none- numeric
alpha               1    -none- numeric
beta                1    -none- numeric
damping.parameter   1    -none- numeric
gamma.one.values    1    -none- numeric
gamma.two.values    1    -none- numeric
ar.coefficients     3    -none- numeric
ma.coefficients     0    -none- NULL
likelihood          1    -none- numeric
optim.return.code   1    -none- numeric
variance            1    -none- numeric
AIC                 1    -none- numeric
parameters          2    -none- list
seed.states         7    -none- numeric
fitted.values      44    ts     numeric
errors             44    ts     numeric
x                 308    -none- numeric
seasonal.periods    1    -none- numeric
k.vector            1    -none- numeric
y                  44    ts     numeric
p                   1    -none- numeric
q                   1    -none- numeric
call                2    -none- call
series              1    -none- character
method              1    -none- character

Forecasts for Time Series ID: 1099
         Qtr1     Qtr2     Qtr3     Qtr4
```

```
1991 4416.318 4728.525 4990.714 5226.756
1992 4786.660 5103.624 5383.298 5622.909

Summary for TBATS model of Time Series ID: 1100
                  Length Class  Mode
lambda              1    -none- numeric
alpha               1    -none- numeric
beta                0    -none- NULL
damping.parameter   0    -none- NULL
gamma.one.values    1    -none- numeric
gamma.two.values    1    -none- numeric
ar.coefficients     3    -none- numeric
ma.coefficients     0    -none- NULL
likelihood          1    -none- numeric
optim.return.code   1    -none- numeric
variance            1    -none- numeric
AIC                 1    -none- numeric
parameters          2    -none- list
seed.states         6    -none- numeric
fitted.values      44    ts     numeric
errors             44    ts     numeric
x                 264    -none- numeric
seasonal.periods    1    -none- numeric
k.vector            1    -none- numeric
y                  44    ts     numeric
p                   1    -none- numeric
q                   1    -none- numeric
call                2    -none- call
series              1    -none- character
method              1    -none- character
```

```
Forecasts for Time Series ID: 1100
         Qtr1     Qtr2     Qtr3     Qtr4
1991 4125.187 4744.753 6675.273 8155.681
1992 4196.629 4695.554 6720.552 8071.406
```

8.40 Code computing the average Mean Absolute Percentage Error (MAPE) and Symmetric Mean Absolute Percentage Error (sMAPE) for the TBATS models and comparing its performance with the Theta and Damped Exponential Smoothing models, which serve as benchmarks (benchmark models fitted in Appendix 8.39)

```r
# Calculate average MAPE and sMAPE for each method
avg_mape_tbats <- mean(mape_tbats, na.rm = TRUE)
avg_smape_tbats <- mean(smape_tbats, na.rm = TRUE)
avg_mape_theta <- mean(mape_theta, na.rm = TRUE)
avg_smape_theta <- mean(smape_theta, na.rm = TRUE)
avg_mape_damped <- mean(mape_damped, na.rm = TRUE)
avg_smape_damped <- mean(smape_damped, na.rm = TRUE)

# Store evaluation metrics for each model in a data frame
tbats_batch_evaluation_metrics <- data.frame(
  Model = c("TBATS", "Theta", "Damped Exponential Smoothing"),
  MAPE = c(avg_mape_tbats, avg_mape_theta, avg_mape_damped),
  sMAPE = c(avg_smape_tbats, avg_smape_theta, avg_smape_damped)
)
```

```r
# Print the evaluation metrics for comparison
cat("Table 21: Error measures evaluating automatic TBATS model's
    out-of-sample accuracy")
print(tbats_batch_evaluation_metrics, row.names = FALSE)

# Select the model with the lowest values for MAPE
tbats_batch_best_model_mape <- tbats_batch_evaluation_metrics[which.min(
    tbats_batch_evaluation_metrics$MAPE), ]

# Select the model with the lowest values for sMAPE
tbats_batch_best_model_smape <- tbats_batch_evaluation_metrics[which.min(
    tbats_batch_evaluation_metrics$sMAPE), ]

# Print the best model
cat("Best model based on MAPE:", tbats_batch_best_model_mape$Model, "\n")
cat("Best model based on sMAPE:", tbats_batch_best_model_smape$Model, "\n")
```

8.41 Code computing the average Mean Absolute Percentage Error (MAPE) and Symmetric Mean Absolute Percentage Error (sMAPE) for all three models and comparing its performance with the Theta and Damped Exponential Smoothing models, which serve as benchmarks

```r
# Store evaluation metrics for each method in a data frame
evaluation_metrics_summary <- data.frame(
  Method = c("ARIMA",
             "ETS",
             "TBATS",
```

```r
                "Theta",
                "Damped Exponential Smoothing"),
  MAPE = c(avg_mape_arima,
           avg_mape_ets,
           avg_mape_tbats,
           avg_mape_theta,
           avg_mape_damped),
  sMAPE = c(avg_smape_arima,
            avg_smape_ets,
            avg_smape_tbats,
            avg_smape_theta,
            avg_smape_damped)
)

# Sort the data frame in ascending order based on both MAPE and sMAPE values
sorted_metrics <- evaluation_metrics_summary[order(
    evaluation_metrics_summary$MAPE, evaluation_metrics_summary$sMAPE), ]

# Print the sorted data frame
cat("Table 22: Error measures evaluating out-of-sample accuracy
    of the automatic models")
print(sorted_metrics, row.names = FALSE)

# Identify the row corresponding to the best model
best_model_row <- sorted_metrics[1, ]

# Print the best model with highlighting
cat("\nBest model based on MAPE and sMAPE:\n")
print(best_model_row, row.names = FALSE)
```