

Package ‘MAARTS’

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Type Package

Title Merger and Acquisition Autoregressive Time-Series Models

Version 1.0.0

Description Implements comprehensive Merger and Acquisition ('M&A') Autoregressive ('AR') time-series models with full statistical analysis capabilities. The package provides parameter estimation, forecasting with confidence intervals (80%, 90%, 95%, 99%), descriptive statistics, stationarity tests (Augmented Dickey-Fuller ('ADF'), Phillips-Perron, Kwiatkowski-Phillips-Schmidt-Shin ('KPSS'), Dickey-Fuller Generalized Least Squares ('DF-GLS')), autocorrelation analysis (Autocorrelation Function ('ACF'), Partial Autocorrelation Function ('PACF')), model diagnostics (Ljung-Box, Box-Pierce), accuracy measures (Mean Squared Error ('MSE'), Mean Absolute Error ('MAE'), Mean Absolute Scaled Error ('MASE'), Root Mean Squared Error ('RMSE'), Symmetric Mean Absolute Percentage Error ('SMAPE'), F-statistic), residual diagnostics (normality tests, heteroscedasticity tests), model stability analysis, impulse response, information criteria (Akaike Information Criterion ('AIC'), Bayesian Information Criterion ('BIC'), Hannan-Quinn Information Criterion ('HQIC')), structural break analysis, spectral analysis, and Monte Carlo simulation. Models are based on:
Kumar, Mudassir, and Agiwal (2024) <<https://ph02.tci-thaijo.org/index.php/thaistat/article/view/253436>>,
Kumar, Mudassir, and Srivastava (2025) <[doi:10.1007/s44199-025-00104-3](https://doi.org/10.1007/s44199-025-00104-3)>,
Kumar and Mudassir (2025) <[doi:10.19139/soic-2310-5070-2029](https://doi.org/10.19139/soic-2310-5070-2029)>.

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ma_accuracy	<i>Forecast Accuracy Measures for M&A Time-Series</i>
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Description

Computes comprehensive forecast accuracy measures including MSE, MAE, RMSE, MAPE, SMAPE, MASE, and Theil’s U statistic.

Usage

```
ma_accuracy(actual, predicted)
```

Arguments

- actual Numeric vector of actual values
- predicted Numeric vector of predicted/forecasted values

Value

An object of class ma_accuracy

Examples

```
actual <- c(1, 2, 3, 4, 5)
predicted <- c(1.1, 2.2, 2.9, 4.1, 5.2)
accuracy <- ma_accuracy(actual, predicted)
```

ma_acf_pacf

*ACF and PACF Analysis for M&A Time-Series***Description**

Computes autocorrelation and partial autocorrelation functions with significance bounds and optional plotting.

Usage

```
ma_acf_pacf(data, lag_max = NULL, plot = TRUE)
```

Arguments

data	A numeric vector or time series object
lag_max	Maximum number of lags (NULL for automatic selection)
plot	Logical. If TRUE, produces ACF and PACF plots.

Value

An object of class `ma_acf_pacf`

Examples

```
data(ma_sample_data)
acf_result <- ma_acf_pacf(ma_sample_data, plot = FALSE)
```

ma_acf_plot

*ACF Plot using ggplot2***Description**

ACF Plot using ggplot2

Usage

```
ma_acf_plot(
  y,
  lag_max = 20,
  confidence_level = 0.95,
  title = "Autocorrelation Function"
)
```

Arguments

y	Numeric vector of time series data
lag_max	Maximum lag
confidence_level	Confidence level for significance bounds
title	Plot title

Value

A [ggplot](#) object showing the autocorrelation function with significance bounds.

ma_ars_model	<i>Merger and Acquisition AR with Spline (M-ARS) Model</i>
--------------	--

Description

Fits an AR model with spline function to account for non-linear trends around merger events.

Usage

```
ma_ars_model(
  y,
  merger_times,
  order = 1,
  knots_before = 1,
  knots_after = 1,
  method = "OLS",
  spline_degree = 1
)
```

Arguments

y	Time series response variable (numeric vector)
merger_times	Vector of merger time points
order	AR order (p)
knots_before	Number of knots before merger
knots_after	Number of knots after merger
method	Estimation method ("OLS", "ALF", "ELF", "SELF")
spline_degree	Degree of spline polynomial (currently linear spline)

Value

List containing model parameters, fitted values, residuals, and diagnostic information

Examples

```
y <- rnorm(100)
result <- ma_ars_model(y, merger_times = c(50), order = 2)
```

ma_ar_fit

AR Model Estimation for M&A Time-Series

Description

Fit an Autoregressive model to M&A time-series data with comprehensive diagnostics.

Usage

```
ma_ar_fit(data, order = NULL, method = "OLS")
```

Arguments

data	A numeric vector or time series object
order	Order of the AR model (p). If NULL, automatically selected using AIC
method	Estimation method ("OLS" or "MLE")

Value

A list containing model fit, parameters, and diagnostics

Examples

```
data(ma_sample_data)
ar_model <- ma_ar_fit(ma_sample_data, order = 2)
```

ma_descriptive_stats

Descriptive Statistics for M&A Time-Series

Description

Computes comprehensive descriptive statistics for M&A time-series data, including measures of central tendency, dispersion, shape, and distribution.

Usage

```
ma_descriptive_stats(data, include_tests = TRUE)
```

Arguments

data	A numeric vector or time series object
include_tests	Logical. If TRUE, runs comprehensive normality tests.

Value

A list of class `ma_descriptive_stats` containing the descriptive statistics.

Examples

```
data(ma_sample_data)
stats <- ma_descriptive_stats(ma_sample_data)
print(stats)
```

ma_diagnostic_tests	<i>Diagnostic Tests for M&A AR Models</i>
---------------------	---

Description

Performs Ljung-Box and Box-Pierce tests for residual autocorrelation.

Usage

```
ma_diagnostic_tests(model, lag = NULL)
```

Arguments

model	A fitted AR model object (<code>ma_ar_fit</code> or <code>ma_ar_model</code> class)
lag	Vector of lag orders to test (default: <code>c(6, 12, 18, 24)</code>)

Value

An object of class `ma_diagnostic_tests`

Examples

```
data(ma_sample_data)
ar_model <- ma_ar_fit(ma_sample_data, order = 2)
diagnostics <- ma_diagnostic_tests(ar_model)
```

ma_forecast	<i>Forecasting for M&A AR Models</i>
-------------	--

Description

Generates forecasts with confidence intervals at multiple levels (80%, 90%, 95%, 99%). Supports both standard AR models (ma_ar_fit) and M&A AR models (ma_ar_model).

Usage

```
ma_forecast(model, h = 10, confidence = c(0.8, 0.9, 0.95, 0.99))
```

Arguments

model	A fitted AR model object (ma_ar_fit or ma_ar_model class)
h	Number of periods to forecast
confidence	Confidence levels for intervals (default: c(0.80, 0.90, 0.95, 0.99))

Value

An object of class ma_forecast

Examples

```
data(ma_sample_data)
ar_model <- ma_ar_fit(ma_sample_data, order = 2)
fc <- ma_forecast(ar_model, h = 12)
```

ma_forecast_plot	<i>Forecast Plot using ggplot2</i>
------------------	------------------------------------

Description

Forecast Plot using ggplot2

Usage

```
ma_forecast_plot(
  forecast_result,
  historical_data = NULL,
  title = "Forecast with Confidence Intervals"
)
```

Arguments

forecast_result	A ma_forecast object
historical_data	Optional vector of historical data
title	Plot title

Value

A [ggplot](#) object showing historical data with forecasts and confidence bands.

ma_histogram_plot	<i>Histogram Plot using ggplot2</i>
-------------------	-------------------------------------

Description

Histogram Plot using ggplot2

Usage

```
ma_histogram_plot(y, bins = 30, title = "Histogram with Density")
```

Arguments

y	Numeric vector
bins	Number of bins
title	Plot title

Value

A [ggplot](#) object showing a histogram with an overlaid normal density curve.

ma_impulse_response	<i>Impulse Response Function for M&A AR Models</i>
---------------------	--

Description

Computes impulse response functions (IRF), dynamic multipliers, and cumulative impulse responses to analyze shock transmission in M&A AR models.

Usage

```
ma_impulse_response(model, n_periods = 20, plot = TRUE)
```

Arguments

model	A fitted AR model object (ma_ar_fit or ma_ar_model class)
n_periods	Number of periods for the impulse response
plot	Logical. If TRUE, produces impulse response plot.

Value

An object of class ma_impulse_response

Examples

```
data(ma_sample_data)
ar_model <- ma_ar_fit(ma_sample_data, order = 2)
irf <- ma_impulse_response(ar_model, n_periods = 20, plot = FALSE)
```

ma_model_comparison	<i>Model Comparison for M&A AR Models</i>
---------------------	---

Description

Compares multiple AR models using information criteria (AIC, BIC, HQIC), log-likelihood values, and accuracy measures.

Usage

```
ma_model_comparison(..., model_names = NULL)
```

Arguments

...	Multiple fitted AR model objects
model_names	Optional character vector of model names

Value

An object of class ma_model_comparison

Examples

```
data(ma_sample_data)
ar1 <- ma_ar_fit(ma_sample_data, order = 1)
ar2 <- ma_ar_fit(ma_sample_data, order = 2)
comparison <- ma_model_comparison(ar1, ar2)
```

`ma_monte_carlo_simulation`*Monte Carlo Simulation for M&A AR Models*

Description

Performs Monte Carlo simulation to evaluate estimator performance. Assesses bias, MSE, RMSE, and coverage probability of confidence intervals.

Usage

```
ma_monte_carlo_simulation(  
  true_coefficients,  
  n = 200,  
  n_sim = 1000,  
  intercept = 0,  
  sigma = 1,  
  confidence_level = 0.95  
)
```

Arguments

<code>true_coefficients</code>	True AR coefficients for data generation
<code>n</code>	Sample size for each simulation
<code>n_sim</code>	Number of simulations
<code>intercept</code>	True intercept value
<code>sigma</code>	True innovation standard deviation
<code>confidence_level</code>	Confidence level for coverage probability

Value

An object of class `ma_monte_carlo_simulation`

Examples

```
sim <- ma_monte_carlo_simulation(true_coefficients = c(0.6, -0.2),  
                                n = 100, n_sim = 100)
```

ma_multiple_merger_ar *Multiple Merger AR Model with Explanatory Series*

Description

Fits an AR model accounting for multiple merger events with explanatory series.

Usage

```
ma_multiple_merger_ar(
  y,
  x_explanatory = list(),
  merger_times = numeric(0),
  order = 1,
  method = "OLS"
)
```

Arguments

y	Time series response variable (numeric vector)
x_explanatory	List of explanatory time series vectors
merger_times	Vector of merger time points
order	AR order (p)
method	Estimation method ("OLS", "ALF", "ELF", "SELF")

Value

List containing model parameters, fitted values, residuals, and diagnostic information

Examples

```
y <- rnorm(100)
x <- list(x1 = rnorm(100), x2 = rnorm(100))
result <- ma_multiple_merger_ar(y, x, merger_times = c(30, 70), order = 2)
```

ma_normality_tests *Normality Tests for M&A Time-Series*

Description

Performs comprehensive normality tests including Shapiro-Wilk, Jarque-Bera, Anderson-Darling, Cramer-von Mises, Pearson chi-square, and Shapiro-Francia tests.

Usage

```
ma_normality_tests(data)
```

Arguments

data A numeric vector or time series object

Value

A list containing the individual test statistics, p-values, and an overall interpretation.

Examples

```
y <- rnorm(100)
tests <- ma_normality_tests(y)
```

ma_pacf_plot	<i>PACF Plot using ggplot2</i>
--------------	--------------------------------

Description

PACF Plot using ggplot2

Usage

```
ma_pacf_plot(
  y,
  lag_max = 20,
  confidence_level = 0.95,
  title = "Partial Autocorrelation Function"
)
```

Arguments

y Numeric vector of time series data

lag_max Maximum lag

confidence_level Confidence level for significance bounds

title Plot title

Value

A [ggplot](#) object showing the partial autocorrelation function with significance bounds.

ma_qq_plot	<i>Normal Q-Q Plot using ggplot2</i>
------------	--------------------------------------

Description

Normal Q-Q Plot using ggplot2

Usage

```
ma_qq_plot(model, title = "Normal Q-Q Plot")
```

Arguments

model	A fitted AR model object (ma_ar_fit or ma_ar_model class)
title	Plot title

Value

A [ggplot](#) object showing a Q-Q plot of residuals against normal quantiles.

ma_residual_diagnostics	<i>Residual Diagnostics for M&A AR Models</i>
-------------------------	---

Description

Performs comprehensive residual diagnostics including normality tests, heteroscedasticity tests (Breusch-Pagan, ARCH LM), and graphical diagnostics.

Usage

```
ma_residual_diagnostics(model, plot = TRUE, lags = c(6, 12, 18))
```

Arguments

model	A fitted AR model object (ma_ar_fit or ma_ar_model class)
plot	Logical. If TRUE, produces diagnostic plots (histogram, Q-Q plot, residuals vs fitted).
lags	Vector of lag orders for autocorrelation tests

Value

An object of class `ma_residual_diagnostics`

Examples

```
data(ma_sample_data)
ar_model <- ma_ar_fit(ma_sample_data, order = 2)
diag <- ma_residual_diagnostics(ar_model, plot = FALSE)
```

ma_residual_plot	<i>Residual Plot using ggplot2</i>
------------------	------------------------------------

Description

Residual Plot using ggplot2

Usage

```
ma_residual_plot(model)
```

Arguments

model A fitted AR model object (ma_ar_fit or ma_ar_model class)

Value

A [ggplot](#) object showing residuals over time.

ma_sample_data	<i>Sample M&A Time-Series Data</i>
----------------	--

Description

A simulated dataset representing Merger and Acquisition activity over time. This data follows an AR(2) process with parameters $\phi_1 = 0.6$, $\phi_2 = -0.2$, intercept = 10, and $\sigma = 2$, typical of M&A time-series dynamics.

Usage

```
ma_sample_data
```

Format

A time-series object (ts) of length 200 representing quarterly M&A activity from 2000 Q1 to 2049 Q4.

Source

Simulated data for demonstration purposes.

Examples

```
data(ma_sample_data)
plot(ma_sample_data, type = "l", main = "Sample M&A Time-Series")
ma_descriptive_stats(ma_sample_data)
```

`ma_spectral_analysis` *Spectral Analysis for M&A Time-Series*

Description

Performs spectral analysis to identify cyclical components in M&A activity using periodogram and spectral density estimation.

Usage

```
ma_spectral_analysis(data, plot = TRUE)
```

Arguments

<code>data</code>	A numeric vector or time series object
<code>plot</code>	Logical. If TRUE, produces spectral density plot.

Value

An object of class `ma_spectral_analysis`

Examples

```
data(ma_sample_data)
spectral <- ma_spectral_analysis(ma_sample_data, plot = FALSE)
```

`ma_stability_analysis` *Stability Analysis for M&A AR Models*

Description

Evaluates the stability and stationarity conditions of AR models through characteristic root analysis, persistence measures, and half-life calculation.

Usage

```
ma_stability_analysis(model)
```

Arguments

<code>model</code>	A fitted AR model object (<code>ma_ar_fit</code> or <code>ma_ar_model</code> class)
--------------------	--

Value

An object of class `ma_stability_analysis`

Examples

```
data(ma_sample_data)
ar_model <- ma_ar_fit(ma_sample_data, order = 2)
stability <- ma_stability_analysis(ar_model)
```

`ma_stationarity_tests` *Stationarity Tests for M&A Time-Series*

Description

Performs comprehensive stationarity and unit root tests on time-series data, including Augmented Dickey-Fuller (ADF), Phillips-Perron (PP), KPSS, and DF-GLS tests.

Usage

```
ma_stationarity_tests(data, lag = NULL, trend = "drift")
```

Arguments

<code>data</code>	A numeric vector or time series object
<code>lag</code>	Maximum lag for the tests (optional, automatically selected if NULL)
<code>trend</code>	Type of trend to assume for KPSS and DF-GLS ("drift" or "trend")

Value

An object of class `ma_stationarity_tests` containing test statistics, critical values, and p-values.

Examples

```
data(ma_sample_data)
stationarity <- ma_stationarity_tests(ma_sample_data)
print(stationarity)
```

ma_structural_break	<i>Structural Break Analysis for M&A Time-Series</i>
---------------------	--

Description

Performs structural break analysis using Chow test, Bai-Perron multiple breakpoint tests, and CUSUM tests to detect changes in M&A dynamics.

Usage

```
ma_structural_break(data, model = NULL, break_point = NULL, max_breaks = 5)
```

Arguments

data	A numeric vector or time series object
model	Optional fitted AR model object
break_point	Optional known breakpoint(s) for Chow test
max_breaks	Maximum number of breakpoints for Bai-Perron test

Value

An object of class `ma_structural_break`

Examples

```
y <- c(rnorm(50), rnorm(50, mean = 2))
breaks <- ma_structural_break(y, break_point = 50)
```

plot.ma_forecast	<i>Plot method for ma_forecast</i>
------------------	------------------------------------

Description

Plot method for `ma_forecast`

Usage

```
## S3 method for class 'ma_forecast'
plot(x, ...)
```

Arguments

x	An object of class <code>ma_forecast</code>
...	Additional arguments (ignored)

Value

The input object x, invisibly. Called for its side effect of producing a forecast plot with confidence bands.

print.ma_accuracy	<i>Print method for ma_accuracy</i>
-------------------	-------------------------------------

Description

Print method for ma_accuracy

Usage

```
## S3 method for class 'ma_accuracy'
print(x, ...)
```

Arguments

x	An object of class ma_accuracy
...	Additional arguments (ignored)

Value

The input object x, invisibly. Called for its side effect of printing a summary of forecast accuracy measures to the console.

print.ma_acf_pacf	<i>Print method for ma_acf_pacf</i>
-------------------	-------------------------------------

Description

Print method for ma_acf_pacf

Usage

```
## S3 method for class 'ma_acf_pacf'
print(x, ...)
```

Arguments

x	An object of class ma_acf_pacf
...	Additional arguments (ignored)

Value

The input object x, invisibly. Called for its side effect of printing ACF/PACF analysis results to the console.

print.ma_ar_fit	<i>Print method for ma_ar_fit</i>
-----------------	-----------------------------------

Description

Print method for ma_ar_fit

Usage

```
## S3 method for class 'ma_ar_fit'  
print(x, ...)
```

Arguments

x	An object of class ma_ar_fit
...	Additional arguments (ignored)

Value

The input object x, invisibly. Called for its side effect of printing model coefficients, information criteria, and stability diagnostics to the console.

print.ma_ar_model	<i>Print method for ma_ar_model</i>
-------------------	-------------------------------------

Description

Print method for ma_ar_model

Usage

```
## S3 method for class 'ma_ar_model'  
print(x, ...)
```

Arguments

x	An object of class ma_ar_model
...	Additional arguments (ignored)

Value

The input object x, invisibly. Called for its side effect of printing model type, AR coefficients, and coefficient summary to the console.

```
print.ma_descriptive_stats
```

Print method for ma_descriptive_stats

Description

Print method for ma_descriptive_stats

Usage

```
## S3 method for class 'ma_descriptive_stats'  
print(x, ...)
```

Arguments

x	An object of class ma_descriptive_stats
...	Additional arguments (ignored)

Value

The input object x, invisibly. Called for its side effect of printing descriptive statistics and normality test results to the console.

```
print.ma_diagnostic_tests
```

Print method for ma_diagnostic_tests

Description

Print method for ma_diagnostic_tests

Usage

```
## S3 method for class 'ma_diagnostic_tests'  
print(x, ...)
```

Arguments

x	An object of class ma_diagnostic_tests
...	Additional arguments (ignored)

Value

The input object x, invisibly. Called for its side effect of printing Ljung-Box and Box-Pierce test results to the console.

print.ma_forecast	<i>Print method for ma_forecast</i>
-------------------	-------------------------------------

Description

Print method for ma_forecast

Usage

```
## S3 method for class 'ma_forecast'  
print(x, ...)
```

Arguments

x	An object of class ma_forecast
...	Additional arguments (ignored)

Value

The input object x, invisibly. Called for its side effect of printing point forecasts and confidence intervals to the console.

print.ma_impulse_response	<i>Print method for ma_impulse_response</i>
---------------------------	---

Description

Print method for ma_impulse_response

Usage

```
## S3 method for class 'ma_impulse_response'  
print(x, ...)
```

Arguments

x	An object of class ma_impulse_response
...	Additional arguments (ignored)

Value

The input object x, invisibly. Called for its side effect of printing impulse response function values and cumulative responses to the console.

```
print.ma_model_comparison
```

Print method for ma_model_comparison

Description

Print method for ma_model_comparison

Usage

```
## S3 method for class 'ma_model_comparison'  
print(x, ...)
```

Arguments

x	An object of class ma_model_comparison
...	Additional arguments (ignored)

Value

The input object x, invisibly. Called for its side effect of printing a model comparison table with information criteria to the console.

```
print.ma_monte_carlo_simulation
```

Print method for ma_monte_carlo_simulation

Description

Print method for ma_monte_carlo_simulation

Usage

```
## S3 method for class 'ma_monte_carlo_simulation'  
print(x, ...)
```

Arguments

x	An object of class ma_monte_carlo_simulation
...	Additional arguments (ignored)

Value

The input object x, invisibly. Called for its side effect of printing Monte Carlo simulation results including bias, MSE, and coverage probabilities to the console.

```
print.ma_residual_diagnostics
```

Print method for ma_residual_diagnostics

Description

Print method for ma_residual_diagnostics

Usage

```
## S3 method for class 'ma_residual_diagnostics'  
print(x, ...)
```

Arguments

x	An object of class ma_residual_diagnostics
...	Additional arguments (ignored)

Value

The input object x, invisibly. Called for its side effect of printing residual summary statistics, normality tests, and heteroscedasticity test results to the console.

```
print.ma_spectral_analysis
```

Print method for ma_spectral_analysis

Description

Print method for ma_spectral_analysis

Usage

```
## S3 method for class 'ma_spectral_analysis'  
print(x, ...)
```

Arguments

x	An object of class ma_spectral_analysis
...	Additional arguments (ignored)

Value

The input object x, invisibly. Called for its side effect of printing dominant frequency, period, and spectral density summary to the console.

```
print.ma_stability_analysis
```

Print method for ma_stability_analysis

Description

Print method for ma_stability_analysis

Usage

```
## S3 method for class 'ma_stability_analysis'  
print(x, ...)
```

Arguments

x	An object of class ma_stability_analysis
...	Additional arguments (ignored)

Value

The input object x, invisibly. Called for its side effect of printing characteristic roots, persistence, half-life, and stability status to the console.

```
print.ma_stationarity_tests
```

Print method for ma_stationarity_tests

Description

Print method for ma_stationarity_tests

Usage

```
## S3 method for class 'ma_stationarity_tests'  
print(x, ...)
```

Arguments

x	An object of class ma_stationarity_tests
...	Additional arguments (ignored)

Value

The input object x, invisibly. Called for its side effect of printing ADF, Phillips-Perron, KPSS, and DF-GLS test results to the console.

```
print.ma_structural_break
```

```
Print method for ma_structural_break
```

Description

Print method for ma_structural_break

Usage

```
## S3 method for class 'ma_structural_break'  
print(x, ...)
```

Arguments

x	An object of class ma_structural_break
...	Additional arguments (ignored)

Value

The input object x, invisibly. Called for its side effect of printing structural break test results to the console.

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