Package ‘markets’

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Title  Estimation Methods for Markets in Equilibrium and Disequilibrium

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Description  Provides estimation methods for markets in equilibrium and disequilibrium. Supports the estimation of an equilibrium and four disequilibrium models with both correlated and independent shocks. Also provides post-estimation analysis tools, such as aggregation, marginal effect, and shortage calculations. See Karapanagiotis (2024) <doi:10.18637/jss.v108.i02> for an overview of the functionality and examples. The estimation methods are based on full information maximum likelihood techniques given in Maddala and Nelson (1974) <doi:10.2307/1914215>. They are implemented using the analytic derivative expressions calculated in Karapanagiotis (2020) <doi:10.2139/ssrn.3525622>. Standard errors can be estimated by adjusting for heteroscedasticity or clustering. The equilibrium estimation constitutes a case of a system of linear, simultaneous equations. Instead, the disequilibrium models replace the market-clearing condition with a non-linear, short-side rule and allow for different specifications of price dynamics.

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     https://markets.pikappa.eu/

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**VignetteBuilder** knitr

**Collate**
- data.R
- equation_base.R
- system_base.R
- model_logger.R
- market_model.R
- disequilibrium_model.R
- diseq_basic.R
- diseq_deterministic_adjustment.R
- diseq_directional.R
- diseq_stochastic_adjustment.R
- equation_basic.R
- equation_deterministic_adjustment.R
- equation_directional.R
- equation_stochastic_adjustment.R
- system_basic.R
- gradient_basic.R
- system_deterministic_adjustment.R
- system_directional.R
- system_equilibrium.R
- system_stochastic_adjustment.R
- gradient_equilibrium.R
- hessian_basic.R
- hessian_directional.R
- likelihood_basic.R
- likelihood_deterministic_adjustment.R
- likelihood_directional.R
- likelihood_equilibrium.R
- market_fit.R
- markets.R
- model_simulation.R

**LinkingTo** Rcpp, RcppGSL

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**Description**

Returns the coefficients of the fitted market model.

**Usage**

```r
## S4 method for signature 'market_fit'
coef(object)
```

```r
## S4 method for signature 'market_fit'
coefficients(object)
```

**Arguments**

- `object` A fitted model object.

**Value**

A named vector of estimated model coefficients.

**Methods (by class)**

- `coef(market_fit)`: Estimated coefficients.
- `coefficients(market_fit)`: Estimated coefficients alias.

**Examples**

```r
# estimate a model using the houses dataset
fit <- diseq_deterministic_adjustment(
  HS | RM | 1D | TREND ~
  RM + TREND + W + CSHS + L1RM + L2RM + MONTH |
  RM + TREND + W + L1RM + MA6DSF + MA3DHF + MONTH,
  fair_houses(),
correlated_shocks = FALSE,
estimation_options = list(control = list(maxit = 1e+6))
)
```
# access the estimated coefficients
coef(fit)
coefficients(fit)

#### Description

All models are estimated using full information maximum likelihood. The `equilibrium_model` can also be estimated using two-stage least squares. The maximum likelihood estimation is based on `optim`. If no starting values are provided, the function uses linear regression estimates as initializing values. The default optimization method is BFGS. For other alternatives see `optim`. The implementation of the two-stage least square estimation of the `equilibrium_model` is based on `lm`.

#### Usage

```r
estimate(object, ...)  # S4 method for signature 'market_model'
estimate(
  object,
  gradient = "calculated",
  hessian = "calculated",
  standard_errors = "homoscedastic",
  ...
)
```

```r
## S4 method for signature 'equilibrium_model'
estimate(object, method = "BFGS", optimizer = "optim", ...)
```

#### Arguments

- `object`: A model object.
- `...`: Additional parameter used in the model’s estimation. These are passed further down to the optimization call. For the `equilibrium_model` model, the parameters are passed to `lm`, if the method is set to 2SLS, or to `optim` for any other method. For the rest of the models, the parameters are passed to `optim`.
- `gradient`: One of two potential options: "numerical" and "calculated". By default, all the models are estimated using the analytic expressions of their likelihoods’ gradients.
- `hessian`: One of three potential options: "skip", "numerical", and "calculated". The default is to use the "calculated" Hessian for the models that expressions are available and the "numerical" Hessian in other cases. Calculated Hessian expressions are available for the basic and directional models.
**standard_errors**  
One of three potential options: "homoscedastic", "heteroscedastic", or a vector with variables names for which standard error clusters are to be created. The default value is "homoscedastic". If the option "heteroscedastic" is passed, the variance-covariance matrix is calculated using heteroscedasticity adjusted (Huber-White) standard errors. If a vector with variable names is supplied, the variance-covariance matrix is calculated by grouping the score matrix based on the passed variables.

**method**  
A string specifying the estimation method. When the passed value is among "Nelder-Mead", "BFGS", "CG", "L-BFGS-B", "SANN", and "Brent", the model is estimated using full information maximum likelihood based on optim functionality. When "2SLS" is supplied, the model is estimated using two-stage least squares via lm. In this case, the function returns a list containing the first and second stage estimates. The default value is "BFGS".

**optimizer**  
One of two options: "optim", "gsl". The default value is "optim". If the option "gsl" is set, the equilibrium likelihood is maximized using GSL.

**Details**  
The likelihood of the equilibrium model can be optimized either by using optim (the default option) or native GSL routines. The caller can override the default behavior by setting the optimizer argument equal to "gsl", in which case GSL routines are used. This does not necessarily result to faster execution times. This functionality is primarily intended for advanced usage. The optim functionality is a fast, analysis-oriented alternative, which is more suitable for most use case.

When optimizer = "gsl" is used, the only available optimization method is BFGS. Additionally, the caller needs to specify in the control list values for the optimization step (step), the objective's optimization tolerance (objective_tolerance), the gradient's optimization tolerance (gradient_tolerance, and the maximum allowed number of iterations (maxit). If the GSL library is not available in the calling machine, the function returns a trivial result list with convergence status set equal to -1. If the C++17 execution policies are available, the implementation of the optimization is parallelized.

**Value**  
A market fit object holding the estimation result.

**Functions**  
- **estimate(market_model)**: Full information maximum likelihood estimation.
- **estimate(equilibrium_model)**: Equilibrium model estimation.

**Examples**

```r
# initialize the model using the houses dataset
model <- new(
  "diseq_deterministic_adjustment", # model type
  subject = ID, time = TREND, quantity = HS, price = RM,
  demand = RM + TREND + W + CSHS + L1RM + L2RM + MONTH,
```


supply = RM + TREND + W + L1RM + MA6DSF + MA3DHF + MONTH,

fair_houses(), # data
correlated_shocks = FALSE # let shocks be independent

# estimate the model object (BFGS is used by default)
fit <- estimate(model)

# estimate the model by specifying the optimization details passed to the optimizer.
fit <- estimate(model, control = list(maxit = 1e+6))

# summarize results
summary(fit)

# simulate an equilibrium model
model <- simulate_model(
  "equilibrium_model", list(
    # observed entities, observed time points
    nobs = 500, tobs = 3,
    # demand coefficients
    alpha_d = -1.9, beta_d0 = 24.9, beta_d = c(2.3, -1.2), eta_d = c(2.0, -1.5),
    # supply coefficients
    alpha_s = .9, beta_s0 = 8.2, beta_s = c(3.3), eta_s = c(1.5, -2.2)
  ),
  seed = 99
)

# maximize the model's log-likelihood
fit <- estimate(
  model,
  optimizer = "gsl", control = list(
    step = 1e-2, objective_tolerance = 1e-8,
    gradient_tolerance = 1e-2, maxit = 1e+3
  )
)

summary(fit)

---

**Market model formula**

**Description**

Market model formula
Usage

```r
## S4 method for signature 'market_model'
formula(x)
```

Arguments

- `x` A market model object.

Details

Market model formulas adhere to the following specification:

```
quantity | price | subject | time ~ demand | supply
```

where

- `quantity`: The model’s traded (observed) quantity variable.
- `price`: The model’s price variable.
- `quantity`: The model’s subject (e.g. firm) identification variable.
- `quantity`: The model’s time identification variable.
- `demand`: The right hand side of the model’s demand equation.
- `supply`: The right hand side of the model’s supply equation.

The `diseq_stochastic_adjustment` additionally specify price dynamics by appending the right hand side of the equation at the end of the formula, i.e.

```
quantity | price | subject | time ~ demand | supply | price_dynamics
```

The left hand side part of the model formula specifies the elements that are needed for initializing the model. The market models of the package prepare the data based on these four variables using their respective identification assumptions. See market model classes for more details.

The function provides access to the formula used in model initialization.

Value

The model’s formula

Examples

```r
model <- simulate_model(
  "diseq_stochastic_adjustment", list(
    # observed entities, observed time points
    nobs = 500, tobs = 3,
    # demand coefficients
    alpha_d = -0.1, beta_d0 = 9.8, beta_d = c(0.3, -0.2), eta_d = c(0.6, -0.1),
    # supply coefficients
    alpha_s = 0.1, beta_s0 = 6.1, beta_s = c(0.9), eta_s = c(-0.5, 0.2),
    # price equation coefficients
    gamma = 1.2, beta_p0 = 3.1, beta_p = c(0.8)
  ),
)```

 houses

seed = 31
)

# access the model's formula
formula(model)

---

| houses | Credit market data for US housing starts |

**Description**

Credit market data for US housing starts

**Usage**

data(houses)

fair_houses()

**Format**

A data frame with 138 rows and 7 columns

**Details**

The basic houses dataset (houses):

A dataset containing the monthly mortgage rates and other attributes of the US market for new, non-farm houses from January 1958 to December 1969 (144 observations). The variables are as follows:

- DATE The date of the record.
- HS Private non-farm housing starts in thousands of units (Not seasonally adjusted).
- RM FHA Mortgage rate series on new homes in units of 100 (beginning-of-month Data).
- DSLA Savings capital (deposits) of savings and loan associations in millions of dollars.
- DMSB Deposits of mutual savings banks in millions of dollars.
- DHLB Advances of the federal home loan bank to savings and loan associations in million of dollars.
- W Number of working days in month.

Generate the variables of the Fair & Jaffee (1972) dataset. (fair_houses):

Loads the houses dataset and creates the additional variables used by Fair & Jaffee (1972) doi:10.2307/1913181. These are

- ID A dummy entity identifier that is always equal to one since the houses data have only a time series component.
• DSF Flow of deposits in savings and loan associations and mutual savings banks in million of dollars. Equal to

\[ DSLA_t + DMSB_t - (DSLA_{t-1} + DMSB_{t-1}). \]

• DHF Flow of advances of the federal home loan bank to savings and loan associations in million of dollars. Equal to

\[ DHLB_t - DHLB_{t-1}. \]

• MONTH The month of the date of the observation.
• L1RM FHA Mortgage rate series on new homes in units of 100, lagged by one date.
• L2RM FHA Mortgage rate series on new homes in units of 100, lagged by two dates.
• L1HS Private non-farm housing starts in thousands of units (Not seasonally adjusted), lagged by one date.
• CSHS The cumulative sum of past housing starts. Used to proxy the stock of houses
• MA6DSF Moving average of order 6 of the flow of deposits in savings associations and loan associations and mutual savings banks.
• MA3DHF Moving average of order 3 of the flow of advances of the federal home loan bank to savings and loan associations.
• TREND A time trend variable.

Returns A modified version of the houses dataset.

Functions

• fair_houses(): Generate Fair & Jaffee (1972) dataset

Source

• HS Economic Reports of the President
• RM Fair (1971)
• DSLA Federal Reserve Bulletins
• DMSB Federal Reserve Bulletins
• DHLB Federal Reserve Bulletins
• W Manually calculated

References

Examples

data(houses)
head(houses)
head(fair_houses())

logLik.market_fit  Log likelihood of a fitted market model

Description
Specializes the logLik function for the market models of the package estimated with full information minimum likelihood. It returns NULL for the equilibrium model estimated with two stage least squares (method = "2SLS").

Usage

## S3 method for class 'market_fit'
logLik(object, ...)

## S4 method for signature 'market_fit'
logLik(object, ...)

Arguments

object A fitted model object.
...
Additional arguments. Unused.

Value

A logLik object.

Examples

# estimate a model using the houses dataset
fit <- diseq_deterministic_adjustment(
  HS | RM | ID | TRENDSD ~
   RM + TRENDSD + W + CSHS + L1RM + L2RM + MONTH |
   RM + TRENDSD + W + L1RM + MA6DSF + MA3DHF + MONTH,
  fair_houses(),
  correlated_shocks = FALSE,
  estimation_options = list(control = list(maxit = 1e+6))
)

# get the log likelihood object
logLik(fit)
Description

Returns the estimated effect of a variable. The effect accounts for both sides of the market. If the given variable belongs only to the demand side, the name of result is prefixed by "D_". If the given variable belongs only to the supply side, the name of result is prefixed by "S_". If the variable can be found both sides, the result name is prefixed by "B_".

Usage

shortage_marginal(fit, variable, model, parameters)

shortage_probability_marginal(
  fit,
  variable,
  aggregate = "mean",
  model,
  parameters
)

## S4 method for signature 'missing,ANY,market_model,ANY'
shortage_marginal(variable, model, parameters)

## S4 method for signature 'missing,ANY,ANY,market_model,ANY'
shortage_probability_marginal(variable, aggregate, model, parameters)

## S4 method for signature 'missing,ANY,market_model,ANY'
shortage_marginal(variable, model, parameters)

## S4 method for signature 'market_fit,ANY,missing,missing'
shortage_marginal(fit, variable)

## S4 method for signature 'market_fit,ANY,ANY,missing,missing'
shortage_probability_marginal(fit, variable, aggregate)

Arguments

fit A fitted market model.
variable Variable name for which the effect is calculated.
model A market model object.
parameters A vector of parameters.
aggregate Mode of aggregation. Valid options are "mean" (the default) and "at_the_mean".
Value

The estimated effect of the passed variable.

Functions

- **shortage_marginal()**: Marginal effect on market system
  Returns the estimated marginal effect of a variable on the market system. For a system variable \( x \) with demand coefficient \( \beta_{d,x} \) and supply coefficient \( \beta_{s,x} \), the marginal effect on the market system is given by
  \[
  M_x = \frac{\beta_{d,x} - \beta_{s,x}}{\sqrt{\sigma^2_d + \sigma^2_s - 2\rho_{ds}\sigma_d\sigma_s}}.
  \]

- **shortage_probability_marginal()**: Marginal effect on shortage probabilities
  Returns the estimated marginal effect of a variable on the probability of observing a shortage state. The mean marginal effect (aggregate = "mean") on the shortage probability is given by
  \[
  M_x E \phi \left( \frac{D - S}{\sqrt{\sigma^2_d + \sigma^2_s - 2\rho_{ds}\sigma_d\sigma_s}} \right)
  \]
  and the marginal effect at the mean (aggregate = "at_the_mean") by
  \[
  M_x \phi \left( \frac{E(D) - S}{\sqrt{\sigma^2_d + \sigma^2_s - 2\rho_{ds}\sigma_d\sigma_s}} \right)
  \]
  where \( M_x \) is the marginal effect on the system, \( D \) is the demanded quantity, \( S \) the supplied quantity, and \( \phi \) is the standard normal density.

Examples

```r
# estimate a model using the houses dataset
fit <- diseq_deterministic_adjustment(
  HS | RM | ID | TREND ~
    RM + TREND + W + CSHS + L1RM + L2RM + MONTH |
    RM + TREND + W + L1RM + MA6DSF + MA3DHF + MONTH,
  fair_houses(),
  correlated_shocks = FALSE,
  estimation_options = list(control = list(maxit = 1e+5))
)

# mean marginal effect of variable "RM" on the shortage probabilities
shortage_probability_marginal(fit, "RM")

# marginal effect at the mean of variable "RM" on the shortage probabilities
shortage_probability_marginal(fit, "CSHS", aggregate = "at_the_mean")

# marginal effect of variable "RM" on the system
shortage_marginal(fit, "RM")
```
Market side aggregation

Description

Market side aggregation

Usage

aggregate_demand(fit, model, parameters)
## S4 method for signature 'missing,market_model,ANY'
aggregate_demand(model, parameters)
aggregate_supply(fit, model, parameters)
## S4 method for signature 'missing,market_model,ANY'
aggregate_supply(model, parameters)
## S4 method for signature 'market_fit,missing,missing'
aggregate_demand(fit)
## S4 method for signature 'market_fit,missing,missing'
aggregate_supply(fit)

Arguments

fit A fitted market model object.
model A model object.
parameters A vector of model’s parameters.

Details

Calculates the sample’s aggregate demand or supply using the estimated coefficients of a fitted model. Alternatively, the function calculates aggregates using a model and a set of parameters passed separately. If the model’s data have multiple distinct subjects at each date (e.g., panel data), aggregation is calculated over subjects per unique date. If the model has time series data, namely a single subject per time point, aggregation is calculated over all time points.

Value

The sum of the estimated demanded or supplied quantities evaluated at the given parameters.

Functions

• aggregate_demand(): Demand aggregation.
• aggregate_supply(): Supply aggregation.
See Also

demanded_quantities, supplied_quantities

Examples

```r
fit <- diseq_basic(
  HS | RM | ID | TREND ~
  RM + TREND + W + CSHS + L1RM + L2RM + MONTH |
  RM + TREND + W + L1RM + MA6DSF + MA3DHF + MONTH,
  fair_houses(),
  correlated_shocks = FALSE
)

# get estimated aggregate demand
aggregate_demand(fit)

# simulate the deterministic adjustment model
model <- simulate_model(
  "diseq_deterministic_adjustment", list(
    # observed entities, observed time points
    nobs = 500, tobs = 3,
    # demand coefficients
    alpha_d = -0.6, beta_d0 = 9.8, beta_d = c(0.3, -0.2), eta_d = c(0.6, -0.1),
    # supply coefficients
    alpha_s = 0.2, beta_s0 = 4.1, beta_s = c(0.9), eta_s = c(-0.5, 0.2),
    # price equation coefficients
    gamma = 0.9
  ),
  seed = 1356
)

# estimate the model object
fit <- estimate(model)

# get estimated aggregate demand
aggregate_demand(fit)

# get estimated aggregate demand
aggregate_supply(fit)
```

Market force data descriptive statistics

Market force data descriptive statistics
Usage

demand_descriptives(object)
supply_descriptives(object)

## S4 method for signature 'market_model'
demand_descriptives(object)

## S4 method for signature 'market_model'
supply_descriptives(object)

Arguments

object A model object.

Details

Calculates and returns basic descriptive statistics for the model’s demand or supply side data. Factor variables are excluded from the calculations. The function calculates and returns:

- nobs Number of observations.
- nmval Number of missing values.
- min Minimum observation.
- max Maximum observation.
- range Observations’ range.
- sum Sum of observations.
- median Median observation.
- mean Mean observation.
- mean_se Mean squared error.
- mean_ce Confidence interval bound.
- var Variance.
- sd Standard deviation.
- coef_var Coefficient of variation.

Value

A data frame containing descriptive statistics.

Functions

- demand_descriptives(): Demand descriptive statistics.
- supply_descriptives(): Supply descriptive statistics.
Examples

```r
# initialize the basic model using the houses dataset
model <- new(
  "diseq_basic", # model type
  subject = ID, time = TREND, quantity = HS, price = RM,
  demand = RM + TREND + W + CSHS + L1RM + L2RM + MONTH,
  supply = RM + TREND + W + L1RM + MA6DSF + MA3DHF + MONTH,
  fair_houses(), # data
  correlated_shocks = FALSE # allow shocks to be correlated
)

# get descriptive statistics of demand side variables
demand_descriptives(model)

# get descriptive statistics of supply side variables
supply_descriptives(model)
```

### Description

This is the estimation output class for all market models of the package. It couples a market model object with estimation results. It provides a common user interface for accessing estimation results, irrespective of the underlying market model used. The estimation results are intended to be accessed by passing `market_fit` objects to methods such as `plot`, `summary`, and `logLik`.

### Details

The `market_fit` class composes the `market_models` class with the estimation results obtained by `optim`, `lm` or GSL. All the public functionality of the underlying market model is also directly accessible from the output class.

Furthermore, the class is responsible for harmonizing the heterogeneous outputs resulting from different estimation methods of market models. For example, a 2SLS estimation of the `equilibrium_model` returns a list of linear regression models (the first stage, demand, and supply models), while the maximum likelihood estimation of `diseq_basic` returns an `optim` list. In both cases, the `market_fit` stores the estimation output in the member `fit` of type list and produces additional harmonized list elements. Methods of the class examine the type of the `fit` and direct execution accordingly to different branches to produce a unified experience for the caller.

### Slots

- **model**: The underlying market model object.
- **fit**: A list holding estimation outputs.

### See Also

`market_models`
Examples

# estimate an equilibrium model using the houses dataset
fit <- equilibrium_model(
  HS | RM | ID | TREND ~
      RM + TREND + W + CSHS + L1RM + L2RM + MONTH |
      RM + TREND + W + L1RM + MA6DSF + MA3DHF + MONTH,
  fair_houses(),
  estimation_options = list(method = "2SLS")
)

# access an method of the underlying model
aggregate_demand(fit)

# summary of results
summary(fit)

Description

Basic disequilibrium model with unknown sample separation (diseq_basic): The basic disequilibrium model consists of three equations. Two of them are the demand and supply equations. In addition, the model replaces the market clearing condition with the short side rule. The model is estimated using full information maximum likelihood.

\[ D_{nt} = X'_{d,nt}\beta_d + u_{d,nt}, \]
\[ S_{nt} = X'_{s,nt}\beta_s + u_{s,nt}, \]
\[ Q_{nt} = \min\{D_{nt}, S_{nt}\}. \]

Disequilibrium model with deterministic price dynamics (diseq_deterministic_adjustment): The disequilibrium model with deterministic price adjustment consists of four equations. The two market equations, the short side rule and price evolution equation. The first two equations are stochastic. The price equation is deterministic. The sample is separated based on the sign of the price changes as in the diseq_directional model. The model is estimated using full information maximum likelihood.

\[ D_{nt} = X'_{d,nt}\beta_d + P_{nt}\alpha_d + u_{d,nt}, \]
\[ S_{nt} = X'_{s,nt}\beta_s + P_{nt}\alpha_s + u_{s,nt}, \]
\[ Q_{nt} = \min\{D_{nt}, S_{nt}\}, \]
\[ \Delta P_{nt} = \frac{1}{\gamma}(D_{nt} - S_{nt}). \]
Directional disequilibrium model with sample separation (diseq_directional): The directional disequilibrium model consists of three equations and a separation rule. The market is described by a linear demand, a linear supply equation and the short side rule. The separation rule splits the sample into states of excess supply and excess demand. If a price change is positive at the time point of the observation, then the observation is classified as being in an excess demand state. Otherwise, it is assumed that it represents an excess supply state. The model is estimated using full information maximum likelihood.

\[
\begin{align*}
D_{nt} &= X'_{d,nt} \beta_d + u_{d,nt}, \\
S_{nt} &= X'_{s,nt} \beta_s + u_{s,nt}, \\
Q_{nt} &= \min\{D_{nt}, S_{nt}\}, \\
\Delta P_{nt} &\geq 0 \Rightarrow D_{nt} \geq S_{nt}.
\end{align*}
\]

Disequilibrium model with stochastic price dynamics (diseq_stochastic_adjustment): The disequilibrium model with stochastic price adjustment is described by a system of four equations. Three of them form a stochastic linear system of market equations coupled with a stochastic price evolution equation. The fourth equation is the short side rule. In contrast to the deterministic counterpart, the model does not impose any separation rule on the sample. It is estimated using full information maximum likelihood.

\[
\begin{align*}
D_{nt} &= X'_{d,nt} \beta_d + P_{nt} \alpha_d + u_{d,nt}, \\
S_{nt} &= X'_{s,nt} \beta_s + P_{nt} \alpha_s + u_{s,nt}, \\
Q_{nt} &= \min\{D_{nt}, S_{nt}\}, \\
\Delta P_{nt} &= \frac{1}{\gamma} (D_{nt} - S_{nt}) + X'_{p,nt} \beta_p + u_{p,nt}.
\end{align*}
\]

Equilibrium model (equilibrium_model): The equilibrium model consists of three equations. The demand, the supply and the market clearing equations. The model can be estimated using both full information maximum likelihood and two-stage least squares.

\[
\begin{align*}
D_{nt} &= X'_{d,nt} \beta_d + P_{nt} \alpha_d + u_{d,nt}, \\
S_{nt} &= X'_{s,nt} \beta_s + P_{nt} \alpha_s + u_{s,nt}, \\
Q_{nt} &= D_{nt} = S_{nt}.
\end{align*}
\]

A necessary identification condition is that there is at least one control that is exclusively part of the demand and one control that is exclusively part of the supply equation. In the first stage of the two-stage least square estimation, prices are regressed on remaining controls from both the demand and supply equations. In the second stage, the demand and supply equation is estimated using the fitted prices instead of the observed.
Slots

- `logger`: Logger object.
- `subject_columns`: Column name for the subject identifier.
- `time_column`: Column name for the time point identifier.
- `explanatory_columns`: Vector of explanatory column names for all model’s equations.
- `data_columns`: Vector of model’s data column names. This is the union of the quantity, price and explanatory columns.
- `columns`: Vector of primary key and data column names for all model’s equations.
- `data`: Model data frame.
- `model_name`: Model name string.
- `market_type`: Market type string.
- `system`: Model’s system of equations.

See Also

- `model_initialization`

---

`market_quantities`  
*Estimated market quantities*

**Description**

Estimated market quantities

**Usage**

demanded_quantities(fit, model, parameters)

```r
## S4 method for signature 'missing,market_model,ANY'
demanded_quantities(model, parameters)
```

supplied_quantities(fit, model, parameters)

```r
## S4 method for signature 'missing,market_model,ANY'
supplied_quantities(model, parameters)
```

```r
## S4 method for signature 'market_fit,missing,missing'
demanded_quantities(fit)
```

```r
## S4 method for signature 'market_fit,missing,missing'
supplied_quantities(fit)
```
Arguments

- **fit**: A fitted model object.
- **model**: A model object.
- **parameters**: A vector of model’s parameters.

Details

Calculates and returns the estimated demanded or supplied quantities for each observation at the passed vector of parameters.

Value

A vector with the market quantities evaluated at the given parameter vector.

Functions

- `demanded_quantities()`: Estimated demanded quantities.
- `supplied_quantities()`: Estimated supplied quantities.

Examples

```r
fit <- diseq_basic(
  HS | RM | ID | TRENDS ~
       RM + TRENDS + W + CSHS + L1RM + L2RM + MONTH |
       RM + TRENDS + W + L1RM + MA6DSF + MA3DHF + MONTH,
       fair_houses(),
       correlated_shocks = FALSE
)

# get estimated demanded and supplied quantities
head(cbind(  
  demanded_quantities(fit),
  supplied_quantities(fit)
))
```

market_simulation  

Market model simulation

Description

Market data and model simulation functionality based on the data generating process induced by the market model specifications.

- **simulate_data**: Returns a data frame with simulated data from a generating process that matches the passed model string. By default, the simulated observations of the controls are drawn from a normal distribution.
simulate_model: Simulates a data frame based on the generating process of the passed model and uses it to initialize a model object. Data are simulated using the `simulate_data` function.

**Usage**

```r
simulate_data(
  model_type_string,
  nobs = NA_integer_,
  tobs = NA_integer_,
  alpha_d = NA_real_,
  beta_d0 = NA_real_,
  beta_d = NA_real_,
  eta_d = NA_real_,
  alpha_s = NA_real_,
  beta_s0 = NA_real_,
  beta_s = NA_real_,
  eta_s = NA_real_,
  gamma = NA_real_,
  beta_p0 = NA_real_,
  beta_p = NA_real_,
  sigma_d = 1,
  sigma_s = 1,
  sigma_p = 1,
  rho_ds = 0,
  rho_dp = 0,
  rho_sp = 0,
  seed = NA_integer_,
  price_generator = function(n) stats::rnorm(n = n),
  control_generator = function(n) stats::rnorm(n = n),
  verbose = 0
)
```

## S4 method for signature 'ANY'

```r
simulate_data(
  model_type_string,
  nobs = NA_integer_,
  tobs = NA_integer_,
  alpha_d = NA_real_,
  beta_d0 = NA_real_,
  beta_d = NA_real_,
  eta_d = NA_real_,
  alpha_s = NA_real_,
  beta_s0 = NA_real_,
  beta_s = NA_real_,
  eta_s = NA_real_,
  gamma = NA_real_,
  beta_p0 = NA_real_,
  beta_p = NA_real_,
  sigma_d = 1,
```
\begin{verbatim}
sigma_s = 1,
sigma_p = 1,
rho_ds = 0,
rho_dp = 0,
rho_sp = 0,
seed = NA_integer_,
price_generator = function(n) stats::rnorm(n = n),
control_generator = function(n) stats::rnorm(n = n),
verbose = 0
)

simulate_model(
    model_type_string,
    simulation_parameters,
    seed = NA,
    verbose = 0,
    correlated_shocks = TRUE
)

## S4 method for signature 'ANY'
simulate_model(
    model_type_string,
    simulation_parameters,
    seed = NA,
    verbose = 0,
    correlated_shocks = TRUE
)

Arguments

model_type_string
    Model type. It should be among equilibrium_model, diseq_basic, diseq_directional, diseq_deterministic_adjustment, and diseq_stochastic_adjustment.

nobs
    Number of simulated entities.

tobs
    Number of simulated dates.

alpha_d
    Price coefficient of demand.

beta_d0
    Constant coefficient of demand.

beta_d
    Coefficients of exclusive demand controls.

Eta_d
    Demand coefficients of common controls.

alpha_s
    Price coefficient of supply.

beta_s0
    Constant coefficient of supply.

beta_s
    Coefficients of exclusive supply controls.

eta_s
    Supply coefficients of common controls.

gamma
    Price equation’s stability factor.

beta_p0
    Price equation’s constant coefficient.
\end{verbatim}
beta_p  Price equation’s control coefficients.
sigma_d  Demand shock’s standard deviation.
sigma_s  Supply shock’s standard deviation.
sigma_p  Price equation shock’s standard deviation.
rho_ds  Demand and supply shocks’ correlation coefficient.
rho_dp  Demand and price shocks’ correlation coefficient.
rho_sp  Supply and price shocks’ correlation coefficient.
seed  Pseudo random number generator seed.

price_generator  
Pseudo random number generator callback for prices. The default generator is $N(0,1)$.

control_generator  
Pseudo random number generator callback for non-price controls. The default generator is $N(0,1)$.

verbose  Verbosity level.

simulation_parameters  List of parameters used in model simulation. See the `simulate_data` function for details.

correlated_shocks  Should the model be estimated using correlated shocks?

Value

simulate_data: The simulated data.
simulate_model: The simulated model

Functions

- `simulate_data()`: Simulate model data.
- `simulate_model()`: Simulate model.

Examples

```r
model <- simulate_model(  
"diseq_stochastic_adjustment", list(  
  # observed entities, observed time points  
  nobs = 500, tobs = 3,  
  # demand coefficients  
  alpha_d = -0.1, beta_d0 = 9.8, beta_d = c(0.3, -0.2), eta_d = c(0.6, -0.1),  
  # supply coefficients  
  alpha_s = 0.1, beta_s0 = 6.1, beta_s = c(0.9), eta_s = c(-0.5, 0.2),  
  # price equation coefficients  
  gamma = 1.2, beta_p0 = 3.1, beta_p = c(0.8)
```
### model_description

Short model and market descriptions

**Description**

- **name**: A unique identifying string for the model.
- **describe**: A short (one-liner) description of the market model.
- **market_type**: A market type string (equilibrium or disequilibrium) for a given model.

**Usage**

```r
name(object)
describe(object)
market_type(object)
```

**Arguments**

- **object**: A model object.
Value

name: The model’s name.

describe: The model’s description.

market_type: The model’s market type.

Functions

• name(): Model name
• describe(): Model description
• market_type(): Market type

Examples

# initialize the equilibrium using the houses dataset
model <- new(
  "diseq_basic", # model type
  subject = ID, time = TREND, quantity = HS, price = RM,
  demand = RM + TREND + W + CSHS + L1RM + L2RM + MONTH,
  supply = RM + TREND + W + L1RM + MA6DSF + MA3DHF + MONTH,
  fair_houses()
)

# model name
name(model)
# model description
describe(model)
# market type
market_type(model)
model_initialization

time,
data,
correlated_shocks = TRUE,
verbose = 0
)

## S4 method for signature 'diseq_deterministic_adjustment'
initialize(
 .Object,
 quantity,
 price,
 demand,
 supply,
 subject,
 time,
 data,
 correlated_shocks = TRUE,
 verbose = 0
)

## S4 method for signature 'diseq_directional'
initialize(
 .Object,
 quantity,
 price,
 demand,
 supply,
 subject,
 time,
 data,
 correlated_shocks = TRUE,
 verbose = 0
)

## S4 method for signature 'diseq_stochastic_adjustment'
initialize(
 .Object,
 quantity,
 price,
 demand,
 supply,
 price_dynamics,
 subject,
 time,
 data,
 correlated_shocks = TRUE,
 verbose = 0
)
## S4 method for signature 'equilibrium_model'
initialize(
  .Object,
  quantity,
  price,
  demand,
  supply,
  subject,
  time,
  data,
  correlated_shocks = TRUE,
  verbose = 0
)

**Arguments**

- **.Object**  The object to be Constructed.
- **quantity**  The quantity variable of the system.
- **price**  The price variable of the system.
- **demand**  A formula representation of the right hand side of the demand equation.
- **supply**  A formula representation of the right hand side of the supply equation.
- **subject**  The subject identifier of the data set.
- **time**  The time identifier of the data set.
- **data**  The data set.
- **correlated_shocks**  Should the model be estimated using correlated shocks?
- **verbose**  Verbosity level.
- **price_dynamics**  A formula representation of the price equation.

**Details**

The following two subsections describe the common initialization steps of all market model classes.

**Variable construction:** The constructor prepares the model’s variables using the passed specifications. The specification variables are expected to be of type language. The right hand side specifications of the system are expected to follow the syntax of formula. The construction of the model’s data uses the variables extracted by these specification. The demand variables are extracted by a formula that uses the quantity on the left hand side and the demand on the right hand side of the formula. The supply variables are constructed by the quantity and the supply inputs. In the case of the diseq_stochastic_adjustment model, the price dynamics’ variables are extracted using the price dynamics input. The price dynamics for the diseq_stochastic_adjustment should contain only terms other than that of excess demand. The excess demand term of the price equation is automatically generated by the constructor.
Data preparation: 1. If the passed data set contains rows with NA values, they are dropped. If the verbosity level allows warnings, a warning is emitted reporting how many rows were dropped. 2. After dropping the rows, factor levels may be invalidated. If needed, the constructor readjusts the factor variables by removing the unobserved levels. Factor indicators and interaction terms are automatically created.
3. The primary key column is constructed by pasting the values of the columns of the subject and time variables.
4. In the cases of the diseq_directional, diseq_deterministic_adjustment, and the diseq_stochastic_adjustment models, a column with lagged prices is constructed. Since lagged prices are unavailable for the observations of the first time point, these observations are dropped. If the verbosity level allows the emission of information messages, the constructor prints the number of dropped observations.
5. In the cases of the diseq_directional and the diseq_stochastic_adjustment models, a column with price differences is created.

Value
The initialized model.

Functions
- initialize(diseq_basic): Basic disequilibrium model base constructor
- initialize(diseq_deterministic_adjustment): Disequilibrium model with deterministic price adjustment constructor
- initialize(diseq_directional): Directional disequilibrium model base constructor
- initialize(diseq_stochastic_adjustment): Disequilibrium model with stochastic price adjustment constructor
- initialize(equilibrium_model): Equilibrium model constructor

Examples

```r
simulated_data <- simulate_data("diseq_basic", 500, 3, # model type, observed entities, observed time points
                           -0.9, 8.9, c(0.3, -0.2), c(-0.03, -0.01), # demand coefficients
                           0.9, 6.2, c(0.03), c(-0.05, 0.02) # supply coefficients
)
# initialize the model
model <- new("diseq_basic", # model type
             subject = id, time = date, quantity = Q, price = P,
             demand = P + Xd1 + Xd2 + X1 + X2, supply = P + Xs1 + X1 + X2,
             simulated_data, # data
             correlated_shocks = FALSE # use independent shocks
)
show(model)
simulated_data <- simulate_data(
    # model type, observed entities and time points
    "diseq_deterministic_adjustment", 500, 3,
```
# demand coefficients
-0.9, 8.9, c(0.03, -0.02), c(-0.03, -0.01),

# supply coefficients
0.9, 4.2, c(0.03), c(0.05, 0.02),

# price adjustment coefficient
1.4

# initialize the model
model <- new(
  "diseq_deterministic_adjustment", # model type
  subject = id, time = date, quantity = Q, price = P,
  demand = P + Xd1 + Xd2 + X1 + X2, supply = P + Xs1 + X1 + X2,
  simulated_data, # data
  correlated_shocks = TRUE # allow shocks to be correlated
)

show(model)

simulated_data <- simulate_data(
  "diseq_directional", 500, 3, # model type, observed entities, observed time points
  -0.2, 4.3, c(0.03, 0.02), c(0.03, 0.01), # demand coefficients
  0.0, 4.0, c(0.03), c(0.05, 0.02) # supply coefficients
)

# in the directional model prices cannot be included in both demand and supply
model <- new(
  "diseq_directional", # model type
  subject = id, time = date, quantity = Q, price = P,
  demand = P + Xd1 + Xd2 + X1 + X2, supply = Xs1 + X1 + X2,
  simulated_data, # data
  correlated_shocks = TRUE # allow shocks to be correlated
)

show(model)

simulated_data <- simulate_data(
  # model type, observed entities and time points
  "diseq_stochastic_adjustment", 500, 3,
  # demand coefficients
  -0.1, 9.8, c(0.3, -0.2), c(0.6, 0.1),
  # supply coefficients
  0.1, 7.1, c(0.9), c(-0.5, 0.2),
  # price adjustment coefficient
  1.4, 3.1, c(0.8)
)

# initialize the model
model <- new(
  "diseq_stochastic_adjustment", # model type
  subject = id, time = date, quantity = Q, price = P,
  demand = P + Xd1 + Xd2 + X1 + X2, supply = P + Xs1 + X1 + X2,
  price_dynamics = Xp1,
simulated_data, # data
correlated_shocks = TRUE # allow shocks to be correlated
)

show(model)
simulated_data <- simulate_data(
  "equilibrium_model", 500, 3, # model type, observed entities and time points
  -0.9, 14.9, c(0.3, -0.2), c(-0.03, -0.01), # demand coefficients
  0.9, 3.2, c(0.3), c(0.5, 0.02) # supply coefficients
)

# initialize the model
model <- new(
  "equilibrium_model", # model type
  subject = id, time = date, quantity = Q, price = P,
  demand = P + Xd1 + Xd2 + X1 + X2, supply = P + Xs1 + X1 + X2,
  simulated_data, # data
correlated_shocks = TRUE # allow shocks to be correlated
)

show(model)

---

model_likelihods  

*Model likelihoods and derivatives*

**Description**


**log_likelihood**: Returns the log-likelihood. The function calculates the model’s log likelihood by evaluating the log likelihood of each observation in the sample and summing the evaluation results.

**gradient**: Returns the gradient of the log-likelihood evaluated at the passed parameters.

**hessian**: Returns the hessian of the log-likelihood evaluated at the passed parameters.

**scores**: It calculates the gradient of the likelihood at the given parameter point for each observation in the sample. It, therefore, returns an n x k matrix, where n denotes the number of observations in the sample and k the number of estimated parameters. The ordering of the parameters is the same as the one that is used in the summary of the results. The method can be called either using directly a fitted model object, or by separately providing a model object and a parameter vector.
Usage

log_likelihood(object, parameters)

gradient(object, parameters)

hessian(object, parameters)

scores(object, parameters, fit)

## S4 method for signature 'diseq_basic'
log_likelihood(object, parameters)

## S4 method for signature 'diseq_basic'
gradient(object, parameters)

## S4 method for signature 'diseq_basic',ANY,ANY'
scores(object, parameters)

## S4 method for signature 'diseq_deterministic_adjustment'
log_likelihood(object, parameters)

## S4 method for signature 'diseq_deterministic_adjustment'
gradient(object, parameters)

## S4 method for signature 'diseq_deterministic_adjustment',ANY,ANY'
scores(object, parameters)

## S4 method for signature 'diseq_directional'
log_likelihood(object, parameters)

## S4 method for signature 'diseq_directional'
gradient(object, parameters)

## S4 method for signature 'diseq_directional',ANY,ANY'
scores(object, parameters)

## S4 method for signature 'diseq_stochastic_adjustment'
log_likelihood(object, parameters)

## S4 method for signature 'diseq_stochastic_adjustment'
gradient(object, parameters)

## S4 method for signature 'diseq_stochastic_adjustment',ANY,ANY'
scores(object, parameters)

## S4 method for signature 'equilibrium_model'
log_likelihood(object, parameters)
## S4 method for signature 'equilibrium_model'
gradient(object, parameters)

## S4 method for signature 'equilibrium_model,ANY,ANY'
scores(object, parameters)

## S4 method for signature 'diseq_basic'
hessian(object, parameters)

## S4 method for signature 'diseq_directional'
hessian(object, parameters)

## S4 method for signature 'missing,missing,market_fit'
scores(fit)

### Arguments

- **object**: A model object.
- **parameters**: A vector of parameters at which the function is to be evaluated.
- **fit**: A fitted model object.

### Value

- **log_likelihood**: The sum of the likelihoods evaluated for each observation.
- **gradient**: The log likelihood's gradient.
- **hessian**: The log likelihood's hessian.
- **scores**: The score matrix.

### Examples

```r
model <- simulate_model("diseq_basic", list(
  # observed entities, observed time points
  nobs = 500, tobs = 3,
  # demand coefficients
  alpha_d = -0.9, beta_d0 = 8.9, beta_d = c(0.6), eta_d = c(-0.2),
  # supply coefficients
  alpha_s = 0.9, beta_s0 = 7.9, beta_s = c(0.03, 1.2), eta_s = c(0.1)
),
  seed = 7523
)

# estimate the model object (BFGS is used by default)
fit <- estimate(model)

# Calculate the score matrix
head(scores(model, coef(fit)))
```

**ncoef**  

*Number of coefficients*

---

**Description**

Returns the number of model's coefficients. This is the sum of demand, supply, price equation, and the variance-covariance matrix coefficients.

**Usage**

```r
ncoef(object)
```

### S4 method for signature 'market_model'

```r
ncoef(object)
```

### S4 method for signature 'market_fit'

```r
ncoef(object)
```

**Arguments**

- **object** A model object.

**Value**

The number of model coefficients.

**Examples**

```r
model <- new(  
  "diseq_basic", # model type  
  subject = ID, time = TREND, quantity = HS, price = RM,  
  demand = RM + TREND + W + CSHS + L1RM + L2RM + MONTH,  
  supply = RM + TREND + W + L1RM + MA6DSF + MA3DHF + MONTH,  
  fair_houses()  
)

# get the number of model coefficients  
ncoef(model)
```
Description

Returns the number of observations that are used by an initialized model. If there are missing values, the number of used observations may differ from the numbers of observations of the data set that was passed to the model’s initialization.

Usage

```
## S4 method for signature 'market_model'
nobs(object)

## S4 method for signature 'market_fit'
nobs(object)
```

Arguments

- `object`: A model object.

Value

The number of used observations.

Examples

```
model <- new(
  "diseq_basic", # model type
  subject = ID, time = TREND, quantity = HS, price = RM,
  demand = RM + TREND + W + CSHS + L1RM + L2RM + MONTH,
  supply = RM + TREND + W + L1RM + MA6DSF + MA3DHF + MONTH,
  fair_houses()
)

# get the number observations
nobs(model)
```
plot,market_fit-method

Plots the fitted model

Description

Displays a graphical illustration of the passed fitted model object. The function creates a scatter plot of quantity-price pairs for the records corresponding to the given subject and time identifiers. Then, it plots the average fitted demand and supply quantities for the same data subset letting prices vary between the minimum and maximum price points observed in the data subset.

Usage

```r
## S4 method for signature 'market_fit'
plot(x, subject, time, show_scatter = TRUE, ...)
```

Arguments

- `x`: A model object.
- `subject`: A vector of subject identifiers to be used in the visualization.
- `time`: A vector of time identifiers to be used in the visualization.
- `show_scatter`: Should the price-quantity scatter be plotted? By default TRUE.
- `...`: Additional parameters to be used for styling the figure. Specifically xlab, ylab, and main are currently handled by the function.

Details

If the `subject` argument is missing, all subjects are used. If the `time` argument is missing, all time points are used. The scatter plot of the quantity-price data can be suppressed by setting `show_scatter = FALSE`.

Value

No return value, called for for side effects (visualization).

Examples

```r
# estimate a model using the houses dataset
fit <- diseq_deterministic_adjustment(
  HS | RM | ID | TREN\n  \n  RM + TREN\n  RM + TREN\n  fair_houses(),
  correlated_shocks = FALSE,
  estimation_options = list(control = list(maxit = 1e+6))
)
```
# show model's illustration plot
plot(fit)

---

shortage_analysis  Analysis of shortages

## Description

The following methods offer functionality for analyzing estimated shortages of the market models. The methods can be called either using directly a fitted model object, or by separately providing a model object and a parameter vector.

## Usage

- `shortages(fit, model, parameters)`
- `normalized_shortages(fit, model, parameters)`
- `relative_shortages(fit, model, parameters)`
- `shortage_probabilities(fit, model, parameters)`
- `shortage_indicators(fit, model, parameters)`
- `shortage_standard_deviation(fit, model, parameters)`

  ## S4 method for signature 'missing,market_model,ANY'
- `shortages(model, parameters)`
- `normalized_shortages(model, parameters)`
- `relative_shortages(model, parameters)`
- `shortage_probabilities(model, parameters)`
- `shortage_indicators(model, parameters)`
- `shortage_standard_deviation(model, parameters)`

  ## S4 method for signature 'missing,diseq_stochastic_adjustment,ANY'
- `shortage_standard_deviation(model, parameters)`

  ## S4 method for signature 'missing,diseq_stochastic_adjustment,ANY'

  ## S4 method for signature 'missing,diseq_stochastic_adjustment,ANY'
shortage_standard_deviation(model, parameters)

## S4 method for signature 'market_fit,missing,missing'
shortages(fit)

## S4 method for signature 'market_fit,missing,missing'
normalized_shortages(fit)

## S4 method for signature 'market_fit,missing,missing'
relative_shortages(fit)

## S4 method for signature 'market_fit,missing,missing'
shortage_probabilities(fit)

## S4 method for signature 'market_fit,missing,missing'
shortage_indicators(fit)

## S4 method for signature 'market_fit,missing,missing'
shortage_standard_deviation(fit)

Arguments

- **fit**: A fitted model object.
- **model**: A market model object.
- **parameters**: A vector of parameters at which the shortages are evaluated.

Details

**shortages**: Returns the predicted shortages at a given point.

**normalized_shortages**: Returns the shortages normalized by the variance of the difference of the shocks at a given point.

**relative_shortages**: Returns the shortages normalized by the supplied quantity at a given point.

**shortage_probabilities**: Returns the shortage probabilities, i.e. the probabilities of an observation coming from an excess demand state, at the given point.

**shortage_indicators**: Returns a vector of indicators (Boolean values) for each observation. An element of the vector is TRUE for observations at which the estimated shortages are non-negative, i.e. the market at an excess demand state. The remaining elements are FALSE. The evaluation of the shortages is performed using the passed parameter vector.

**shortage_standard_deviation**: Returns the standard deviation of excess demand.

Value

A vector with the (estimated) shortages.
Functions

- shortages(): Shortages.
- normalized_shortages(): Normalized shortages.
- relative_shortages(): Relative shortages.
- shortage_probabilities(): Shortage probabilities.
- shortage_indicators(): Shortage indicators.
- shortage_standard_deviation(): Shortage standard deviation.

Examples

# estimate a model using the houses dataset
fit <- diseq_deterministic_adjustment(
  HS ~ RM | ID | TREND ~
  RM + TREND + W + CSHS + L1RM + L2RM + MONTH |
  RM + TREND + W + L1RM + MA6DSF + MA3DHF + MONTH,
  fair_houses(),
  correlated_shocks = FALSE,
  estimation_options = list(control = list(maxit = 1e+5))
)

# get estimated normalized shortages
head(normalized_shortages(fit))

# get estimated relative shortages
head(relative_shortages(fit))

# get the estimated shortage probabilities
head(shortage_probabilities(fit))

# get the estimated shortage indicators
head(shortage_indicators(fit))

# get the estimated shortages
head(shortages(fit))

# get the estimated shortage standard deviation
shortage_standard_deviation(fit)

show,market_model-method

Prints a short description of the model

Description

Sends basic information about the model to standard output.
**Usage**

```r
## S4 method for signature 'market_model'
show(object)

## S4 method for signature 'market_fit'
show(object)
```

**Arguments**

- `object` A model object.

**Value**

No return value, called for side effects (print basic model information).

**Examples**

```r
fit <- equilibrium_model(
  HS | RM | ID | TRENDE ~
  RM + TRENDE + W + CSHS + L1RM + L2RM + MONTH |
  RM + TRENDE + W + L1RM + MA6DSF + MA3DHF + MONTH,
  fair_houses(),
  estimation_options = list(method = "2SLS")
)

# print model information
show(fit@model)

# print fit information
show(fit)
```
estimation_options = list()

## S4 method for signature 'formula'
diseq_basic(
  specification,
  data,
  correlated_shocks = TRUE,
  verbose = 0,
  estimation_options = list()
)

diseq_deterministic_adjustment(
  specification,
  data,
  correlated_shocks = TRUE,
  verbose = 0,
  estimation_options = list()
)

## S4 method for signature 'formula'
diseq_deterministic_adjustment(
  specification,
  data,
  correlated_shocks = TRUE,
  verbose = 0,
  estimation_options = list()
)

diseq_directional(
  specification,
  data,
  correlated_shocks = TRUE,
  verbose = 0,
  estimation_options = list()
)

## S4 method for signature 'formula'
diseq_directional(
  specification,
  data,
  correlated_shocks = TRUE,
  verbose = 0,
  estimation_options = list()
)

diseq_stochastic_adjustment(
  specification,
Arguments

- **specification**: The model’s formula.
- **data**: The data to be used with the model.
- **correlated_shocks**: Should the model’s system entail correlated shocks? By default the argument is set to TRUE.
- **verbose**: The verbosity with which operations on the model print messages. By default the value is set to 0, which prints only errors.
- **estimation_options**: A list with options to be used in the estimation call. See `estimate` for the available options.

Details

The functions of this section combine model initialization and estimation into a single call. They also provide a less verbose interface to the functionality of the package. The functions expect a for-
Formula following the specification described in `formula`, a dataset, and optionally further initialization and estimation options (see `model initialization` and `model estimation` respectively).

Estimation options are expected to be given in the argument `estimation_options` in a form of a `list`. The list names should correspond to variables of the `estimate` function. As a result, optimization options, which are customized using the control argument of `estimate` can be passed as an element of `estimation_options`.

Each of these functions parses the given formula, initializes the model specified by the function’s name, fits the model to the given data using the estimation options and returns fitted model.

### Value

The fitted model.

### Functions

- `diseq_basic()`: Basic disequilibrium model.
- `diseq_deterministic_adjustment()`: Disequilibrium model with deterministic price adjustments.
- `diseq_directional()`: Directional disequilibrium model.
- `diseq_stochastic_adjustment()`: Disequilibrium model with stochastic price adjustments.
- `equilibrium_model()`: Equilibrium model

### Examples

```r
# An example of estimating the equilibrium model
eq <- equilibrium_model(
  HS | RM | ID | TREND ~ RM + TREND + W + CSHS + L1RM + L2RM + MONTH |
  RM + TREND + W + L1RM + MA6DSF + MA3DHF + MONTH,
  fair_houses(), estimation_options = list(control = list(maxit = 5000))
)

# An example of estimating the deterministic adjustment model
da <- diseq_deterministic_adjustment(
  HS | RM | ID | TREND ~ RM + TREND + W + CSHS + L1RM + L2RM + MONTH |
  RM + TREND + W + L1RM + MA6DSF + MA3DHF + MONTH,
  fair_houses(), method = "Nelder-Mead", control = list(maxit = 5000)
)

# An example of estimating the directional model
dr <- diseq_directional(
  HS | RM | ID | TREND ~ TREND ~ RM + W + CSHS + L1RM + L2RM |
  RM + TREND + W + MA6DSF + MA3DHF + MONTH,
  fair_houses(), estimation_options = list(method = "Nelder-Mead", control = list(maxit = 5000))
)
```

# An example of estimating the basic model

```r
start <- coef(eq)
start <- start[[names(start) != "RHO"]]
bs <- diseq_basic(
  HS | RM | ID | TREND ~ RM + TREND + W + CSHS + L1RM + L2RM + MONTH |
  RM + TREND + W + L1RM + MA6DSF + MA3DHF + MONTH,
  fair_houses(), verbose = 2, correlated_shocks = FALSE,
  estimation_options = list(
    start = start,
    control = list(maxit = 5000)
  )
)
```

# An example of estimating the stochastic adjustment model

```r
sa <- diseq_stochastic_adjustment(
  HS | RM | ID | TREND ~ RM + TREND + W + CSHS + MONTH |
  RM + TREND + W + L1RM + L2RM + MA6DSF + MA3DHF + MONTH |
  TREND + L2RM + L3RM,
  fair_houses() |> dplyr::mutate(L3RM = dplyr::lag(RM, 3)),
  correlated_shocks = FALSE,
  estimation_options = list(
    control = list(maxit = 5000), standard_errors = c("W")
  )
)
```

---

**Summary**

**Model and fit summaries**

**Description**

Methods that summarize models and their estimates.

**market_model**: Prints basic information about the passed model object. In addition to the output of the `show` method, summary prints

- the number of observations,
- the number of observations in each equation for models with sample separation, and
- various categories of variables.

**market_fit**: Prints basic information about the passed model fit. In addition to the output of the model’s `summary` method, the function prints basic estimation results. For a maximum likelihood estimation, the function prints

- the used optimization method,
- the maximum number of allowed iterations,
- the relative convergence tolerance (see `optim`),
- the convergence status,
• the initializing parameter values,
• the estimated coefficients, their standard errors, Z values, and P values, and
• $-2 \log L$ evaluated at the maximum.

For a linear estimation of the equilibrium system, the function prints
• the used method,
• the summary of the first stage regression,
• the summary of the demand (second stage) regression, and
• the summary of the supply (second stage) regression.

Usage

```r
## S4 method for signature 'market_model'
summary(object)
```

```r
## S4 method for signature 'market_fit'
summary(object)
```

Arguments

object 
An object to be summarized.

Value

No return value, called for for side effects (print summary).

Methods (by class)

• summary(market_model): Summarizes the model.
• summary(market_fit): Summarizes the model’s fit.

Examples

```r
model <- simulate_model(
  "diseq_stochastic_adjustment", list(
    # observed entities, observed time points
    nobs = 500, tobs = 3,
    # demand coefficients
    alpha_d = -0.1, beta_d0 = 9.8, beta_d = c(0.3, -0.2), eta_d = c(0.6, -0.1),
    # supply coefficients
    alpha_s = 0.1, beta_s0 = 5.1, beta_s = c(0.9), eta_s = c(-0.5, 0.2),
    # price equation coefficients
    gamma = 1.2, beta_p0 = 3.1, beta_p = c(0.8)
  ),
  seed = 556
)

# print model summary
```
summary(model)

# estimate
fit <- estimate(model)

# print estimation summary
summary(fit)

vcov,market_fit-method
Variance-covariance matrix for a fitted market model

Description

Returns the variance-covariance matrix of the estimated coefficients for the fitted model. Specializes the `vcov` function for fitted market models.

Usage

```r
## S4 method for signature 'market_fit'
vcov(object)
```

Arguments

- `object` A fitted model object.

Value

A matrix of covariances for the estimated model coefficients.

Examples

# estimate a model using the houses dataset
fit <- diseq_deterministic_adjustment(
    HS | RM | ID | TREND ~
    RM + TREND + W + CSHS + L1RM + L2RM + MONTH |
    RM + TREND + W + L1RM + MA6DSF + MA3DHF + MONTH,
    fair_houses(),
    correlated_shocks = FALSE,
    estimation_options = list(control = list(maxit = 1e+6))
)

# access the variance-covariance matrix
head(vcov(fit))
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