Package 'esreg'

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Type Package

Title Joint Quantile and Expected Shortfall Regression

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Description
Simultaneous modeling of the quantile and the expected shortfall of a response variable given a set of covariates, see Dimitriadis and Bayer (2017) <arXiv:1704.02213>.

License GPL-3

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LazyData true

Imports quantreg, Rcpp, stats

Suggests GenSA

LinkingTo Rcpp, RcppArmadillo

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R topics documented:

esreg *Joint Quantile and Expected Shortfall Regression*

Description

Estimates a joint linear regression model for the pair (VaR, ES):

$$Q_\alpha(Y|X) = X'\beta_q$$

$$ES_\alpha(Y|X) = X'\beta_e$$

Usage

```
esreg(formula, data, alpha, g1 = 2L, g2 = 1L, target = "rho",
  shift_data = TRUE, method = "ils", control = list(terminate_after = 10,
  max.time = 10, box = 10))
```

Arguments

formula	Formula object, e.g.: y ~ x1 + x2 + ...
data	data.frame that holds the variables. If missing the data is extracted from the environment.
alpha	Probability level
g1	1, 2 (see G1_fun, G1_prime_fun). Default is 1.
g2	1, 2, 3, 4, 5 (see G2_curly_fun, G2_fun, G2_prime_fun). Default is 2.
target	The functions to be optimized: either the loss (rho) or the moment function (psi). Optimization of the loss function is strongly recommended.
shift_data	If g2 is 1, 2 or 3, we can either estimate the model without or with shifting of the Y variable. We either risk biased estimates (no shifting) or slightly different estimates due to the changed loss function (shifting). Defaults to shifting to avoid biased estimates.
method	Iterated local search (ils) or Simulated annealing (sa). Defaults to ils for reasons of computation speed.
control	A list with control parameters passed to either the ils or sa: • terminate_after - Stop the iterated local search if there is no improvement within max_step consecutive steps. Default is 10. • max.time - Maximum running time of the sa optimizer. • box - Box around the parameters for the sa optimizer.

Value

An esreg object

References

A Joint Quantile and Expected Shortfall Regression Framework

See Also

vcov.esreg for the covariance estimation and summary.esreg for a summary of the regression results

Examples

```
# Simulate data (DGP-(2) in the linked paper)
set.seed(0)
x <- rchisq(2000, df=1)
y <- -x + (1 + 0.5 * x) * rnorm(1000)

# True quantile and expected shortfall regression parameters (for alpha=0.025)
alpha=0.025
true_pars <- c(-1.959964, -1.979982, -2.337803, -2.168901)

# Estimate the model using the standard settings
fit <- esreg(y ~ x, alpha=alpha)

# Compare the different variance-covariance estimators
cov1 <- vcov(object=fit, sparsity="iid", cond_var="ind")
cov2 <- vcov(object=fit, sparsity="nid", cond_var="scl_N")
cov3 <- vcov(object=fit, sparsity="nid", cond_var="scl_sp")

print("Comparison of the variance-covariance estimators")
print(rbind(Truth=true_pars,
            Estimate=coef(fit),
            SE_iid_ind=sqrt(diag(cov1)),
            SE_ind_N=sqrt(diag(cov2)),
            SE_ind_sp=sqrt(diag(cov3))))

# Compares estimates using different G2 functions
fit1 <- esreg(y ~ x, alpha=alpha, g2=1)
fit2 <- esreg(y ~ x, alpha=alpha, g2=2)
fit3 <- esreg(y ~ x, alpha=alpha, g2=3)
fit4 <- esreg(y ~ x, alpha=alpha, g2=4)
fit5 <- esreg(y ~ x, alpha=alpha, g2=5)
fits <- sapply(list(fit1, fit2, fit3, fit4, fit5), coef)
colnames(fits) <- sapply(1:5, function(i) esreg:::.G_function_names(1, i)[2])
print("Comparison of the five G2 functions")
print(rbind(Truth=true_pars, t(fits)))

# Compare the M- and Z-estimator
fit_m <- esreg(y ~ x, alpha=alpha, target="rho")
fit_z <- esreg(y ~ x, alpha=alpha, target="psi")
print("Comparison of the M- and Z-estimator")
print(t(cbind(Truth=true_pars, M=coef(fit_m), Z=coef(fit_z))))
```

esreg_twostep *Two Step Quantile and Expected Shortfall Regression*

Description

Estimates the expected shortfall in two steps. First a linear quantile regression, then a weighted least squares regression (see the Oracle estimator in the references for a brief explanation). This estimator is much faster than the joint estimator esreg. However, the estimates are often less precise and it is recommended primarily if one needs estimates quickly.

Usage

```
esreg_twostep(formula, data, alpha)
```

Arguments

formula	Formula object, e.g.: y ~ x1 + x2 + ...
data	data.frame that holds the variables. Can be missing.
alpha	Probability level

References

A Joint Quantile and Expected Shortfall Regression Framework

See Also

vcov.esreg_twostep for the covariance estimation and summary.esreg_twostep for a summary of the regression results

Examples

```
# Simulate data (DGP-(2) in the linked paper)
set.seed(0)
x <- rchisq(2000, df=1)
y <- -x + (1 + 0.5 * x) * rnorm(1000)

# True quantile and expected shortfall regression parameters (for alpha=0.025)
alpha=0.025
true_pars <- c(-1.959964, -1.979982, -2.337803, -2.168901)

# Joint estimator
fit_joint <- esreg(y ~ x, alpha=alpha)

# Two-step estimator
fit_twostep <- esreg_twostep(y ~ x, alpha=alpha)

# Compare the estimates
print(rbind(Truth=true_pars, Joint=coef(fit_joint), `Two-Step`=coef(fit_twostep)))
```

```
# ... and the estimation times
print(c(Joint=fit_joint$time, `Two Step`=fit_twostep$time))
```

`esr_loss` *Joint Quantile and Expected Shortfall Loss Function*

Description

Computes the joint (VaR, ES) loss

Usage

```
esr_loss(r, q, e, alpha, g1 = 2L, g2 = 1L, return_mean = TRUE)
```

Arguments

`r`	Vector of returns
`q`	Vector of quantiles
`e`	Vector of expected shortfalls
`alpha`	Probability level
`g1`	1, 2, see G1_fun
`g2`	1, 2, 3, 4, 5, see G2_curly_fun, G2_fun
`return_mean`	If TRUE returns the average tick loss, else the individual values

References

Fissler and Ziegel (2016)

`gpl` *Generalized Piecewise Linear Loss Function*

Description

Equivalent to the tick / check loss when g is the identity function.

Usage

```
gpl(r, q, alpha, g = function(x) x, return_mean = TRUE)
```

Arguments

r	Vector of returns
q	Vector of quantiles
alpha	Probability level
g	A nondecreasing function
return_mean	If TRUE returns the average tick loss, else the individual values

References

Gneiting (2011)

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vcov.esreg *Covariance Estimation for esreg*

Description

Estimate the variance-covariance matrix of the joint (VaR, ES) estimator either using the asymptotic formulas or using the bootstrap.

Usage

```
## S3 method for class 'esreg'
vcov(object, sparsity = "iid", cond_var = "ind",
  bandwidth_type = "Hall-Sheather", bootstrap_method = NULL, B = 1000,
  block_length = NULL, ...)
```

Arguments

object	An esreg object
sparsity	Sparsity estimator (default: iid), see density_quantile_function for more details. • iid - Piecewise linear interpolation of the distribution • nid - Hendricks and Koenker sandwich
cond_var	Conditional truncated variance estimator (default: ind), see conditional_truncated_variance for more details. • ind - Variance over all negative residuals • scl_N - Scaling with the normal distribution • scl_sp - Scaling with the kernel density function
bandwidth_type	Bofinger, Chamberlain or Hall-Sheather
bootstrap_method	(default: NULL) • NULL - Use the asymptotic estimator • iid - Apply the iid bootstrap (Efron, 1979) • stationary - Apply the stationary bootstrap (Politis & Romano, 1994)

B	Number of bootstrap iterations
block_length	Average block length for the stationary bootstrap
...	additional arguments

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vcov.esreg_twostep *Covariance Estimation for esreg_twostep*

Description

Estimate the variance-covariance matrix of the joint (VaR, ES) estimator either using the asymptotic formulas or using the bootstrap.

Usage

```
## S3 method for class 'esreg_twostep'
vcov(object, sparsity = "iid", cond_var = "ind",
  bandwidth_type = "Hall-Sheather", bootstrap_method = NULL, B = 1000,
  block_length = NULL, ...)
```

Arguments

object	An esreg object
sparsity	Sparsity estimator (default: iid), see density_quantile_function for more details. • iid - Piecewise linear interpolation of the distribution • nid - Hendricks and Koenker sandwich
cond_var	Conditional truncated variance estimator (default: ind), see conditional_truncated_variance for more details. • ind - Variance over all negative residuals • scl_N - Scaling with the normal distribution • scl_sp - Scaling with the kernel density function
bandwidth_type	Bofinger, Chamberlain or Hall-Sheather
bootstrap_method	(default: NULL) • NULL - Use the asymptotic estimator • iid - Apply the iid bootstrap (Efron, 1979) • stationary - Apply the stationary bootstrap (Politis & Romano, 1994)
B	Number of bootstrap iterations
block_length	Average block length for the stationary bootstrap
...	additional arguments

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