Package 'vasicekfit'

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Title Extended Vasicek Credit Loss Model with Macroeconomic Factors

Version 0.1.0

Description Fits the extended Vasicek single-factor credit loss model where the probability of default depends on macroeconomic covariates. Maximum likelihood estimates of all parameters, including asset value correlation, are obtained via closed-form probit-transformed OLS regression; see Mayorov (2026) <doi:10.2139/ssrn.6506378> for derivation.

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Imports stats

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Contents

vasicekfit-package *Extended Vasicek Credit Loss Model with Macroeconomic Factors*

Description

Fits the extended Vasicek single-factor credit loss model where the probability of default depends on macroeconomic covariates. Maximum likelihood estimates of all parameters, including asset value correlation, are obtained via closed-form probit-transformed OLS regression. Also provides density, distribution, quantile, and random generation functions for the Vasicek loss distribution.

Author(s)

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References

Vasicek, O. A. (2002). The distribution of loan portfolio value. *Risk*, 15(12), 160–162.

Yang, B. H. (2014). Estimating Long-Run PD, Asset Correlation, and Portfolio Level PD by Vasicek Models. MPRA Paper No. 57244.

See Also

`vasicekfit`, `predict.vasicekfit`, `dvasicek`

predict.vasicekfit *Predict Method for vasicekfit Objects*

Description

Obtain predictions from a fitted Vasicek model, optionally at specified confidence levels.

Usage

```
## S3 method for class 'vasicekfit'
predict(object, newdata = NULL,
        type = c("link", "response"), alpha = NULL, ...)
```

Arguments

`object`	a `vasicekfit` object.
`newdata`	an optional data frame of new predictor values. If omitted, the training data are used.
`type`	character; `"link"` (default) returns predictions in probit space, `"response"` back-transforms to the (0, 1) loss-rate scale.
`alpha`	optional numeric vector of confidence levels in (0, 1). When supplied, predictions are conditional quantiles of the loss distribution at each confidence level.
`...`	additional arguments (currently unused).

Value

If alpha is NULL, a numeric vector of predictions. If alpha is supplied, a matrix with rows corresponding to observations and columns to confidence levels. When alpha is a scalar, the result is a vector.

See Also

vasicekfit

Examples

```
set.seed(42)
n <- 100
u <- rnorm(n)
x <- pnorm((qnorm(0.03) + 0.1 * u + sqrt(0.02) * rnorm(n)) / sqrt(1 - 0.02))
d <- data.frame(default_rate = x, macro = u)
fit <- vasicekfit(default_rate ~ macro, data = d)

# Conditional mean PD
predict(fit, type = "response")

# 99th percentile loss rate under stress
predict(fit, newdata = data.frame(macro = 2), alpha = 0.99,
        type = "response")

# Multiple confidence levels
predict(fit, newdata = data.frame(macro = c(0, 1, 2)),
        alpha = c(0.95, 0.99, 0.999), type = "response")
```

Vasicek *The Vasicek Loss Distribution*

Description

Density, distribution function, quantile function, and random generation for the Vasicek credit loss distribution.

Usage

```
dvasicek(x, p, rho, kappa = NULL, u = NULL, log = FALSE)
pvasicek(q, p, rho, kappa = NULL, u = NULL, lower.tail = TRUE, log.p = FALSE)
qvasicek(prob, p, rho, kappa = NULL, u = NULL, lower.tail = TRUE, log.p = FALSE)
rvasicek(n, p, rho, kappa = NULL, u = NULL)
```

Arguments

x, q	vector of quantiles (loss rates in (0, 1)).
prob	vector of probabilities.
n	number of observations to generate.
p	probability of default, in (0, 1).
rho	asset value correlation, in (0, 1).
kappa	optional numeric vector of macro-factor sensitivities.
u	optional numeric vector of macro-factor values, same length as kappa.
log, log.p	logical; if TRUE, probabilities/densities are given as log(p).
lower.tail	logical; if TRUE (default), probabilities are $P[X \leq x]$, otherwise $P[X > x]$.

Details

The Vasicek loss distribution arises from the single-factor Gaussian copula model. Its probability density function is

$$f(x) = \sqrt{\frac{1-\rho}{\rho}} \exp\left\{ \frac{1}{2} \left(\Phi^{-1}(x)^2 - \left[\frac{\sqrt{1-\rho}\,\Phi^{-1}(x) - \sum \kappa_j u_j - \Phi^{-1}(p)}{\sqrt{\rho}} \right]^2 \right) \right\}$$

When kappa and u are NULL, this reduces to the standard two-parameter Vasicek distribution.

Value

dvasicek gives the density, pvasicek gives the distribution function, qvasicek gives the quantile function, and rvasicek generates random deviates.

References

Vasicek, O. A. (2002). The distribution of loan portfolio value. *Risk*, 15(12), 160–162.

See Also

vasicekfit

Examples

```
# Standard Vasicek density
curve(dvasicek(x, p = 0.03, rho = 0.10), from = 0.001, to = 0.20,
      ylab = "Density", main = "Vasicek loss distribution")

# 99th percentile (Basel-style)
qvasicek(0.99, p = 0.03, rho = 0.10)

# Check CDF and quantile are inverses
qvasicek(pvasicek(0.05, p = 0.03, rho = 0.10), p = 0.03, rho = 0.10)

# Random sample
```

```
set.seed(1)
hist(rvasicek(10000, p = 0.03, rho = 0.10), breaks = 100,
     main = "Vasicek loss distribution samples")
```

`vasicekfit` *Fit an Extended Vasicek Credit Loss Model*

Description

Fits the extended Vasicek single-factor credit loss model where the probability of default depends on macroeconomic covariates. All parameters, including asset value correlation, are estimated via closed-form probit-transformed OLS.

Usage

```
vasicekfit(formula, data, bias_correct = FALSE, portfolio_size = NULL)
```

Arguments

`formula`	a formula of the form `response ~ predictors` where the response is an observed default/loss rate in (0, 1).
`data`	a data frame containing the variables in `formula`.
`bias_correct`	logical; if `TRUE`, apply the small-sample bias correction to the variance estimate by multiplying by $N/(N - m - 1)$, where N is number of observations and m is number of predictors.
`portfolio_size`	optional positive integer. If supplied, a finite-portfolio variance correction is applied to the response before fitting (see Yang, 2014, section 4.3).

Value

An object of class `"vasicekfit"`, which is a list containing:

p estimated probability of default (baseline PD).

rho estimated asset value correlation.

kappa named numeric vector of macro-factor sensitivities.

sigma2 MLE variance estimate in probit space.

lm_fit the underlying `lm` object.

fitted.values fitted values in probit (Y) space.

residuals residuals in probit (Y) space.

formula the model formula.

call the matched call.

terms the `terms` object.

model the model frame.

bias_correct logical flag used.

portfolio_size portfolio size used, or `NULL`.

References

Vasicek, O. A. (2002). The distribution of loan portfolio value. *Risk*, 15(12), 160–162.

Yang, B. H. (2014). Estimating Long-Run PD, Asset Correlation, and Portfolio Level PD by Vasicek Models. MPRA Paper No. 57244.

See Also

`predict.vasicekfit`, `dvasicek`

Examples

```
set.seed(42)
n <- 100
u1 <- rnorm(n)
u2 <- rnorm(n)
p_true <- 0.03; rho_true <- 0.02
kappa_true <- c(0.13, -0.07)
z <- rnorm(n)
x <- pnorm((qnorm(p_true) + kappa_true[1] * u1 + kappa_true[2] * u2 +
  sqrt(rho_true) * z) / sqrt(1 - rho_true))
d <- data.frame(default_rate = x, unemp = u1, hpi = u2)
fit <- vasicekfit(default_rate ~ unemp + hpi, data = d)
fit
```

`vasicekfit-methods` *Methods for vasicekfit Objects*

Description

Print, summary, coefficient extraction, covariance, confidence interval, and accessor methods for `"vasicekfit"` objects.

Usage

```
## S3 method for class 'vasicekfit'
print(x, ...)
## S3 method for class 'vasicekfit'
summary(object, ...)
## S3 method for class 'vasicekfit'
coef(object, ...)
## S3 method for class 'vasicekfit'
fitted(object, ...)
## S3 method for class 'vasicekfit'
residuals(object, ...)
## S3 method for class 'vasicekfit'
vcov(object, ...)
## S3 method for class 'vasicekfit'
confint(object, parm, level = 0.95, ...)
```

Arguments

x, object	a vasicekfit object.
parm	a specification of which parameters to compute confidence intervals for, either a vector of names or indices. If missing, all parameters are considered.
level	the confidence level required.
...	additional arguments (currently unused).

Details

coef returns the recovered Vasicek parameters (p, rho, and kappas) in the original parameter space.

fitted and residuals return values in probit (Y) space, consistent with the underlying OLS regression.

vcov returns the delta-method covariance matrix for the original-space parameters $(p, \rho, \kappa_1, \ldots, \kappa_m)$, obtained by propagating the joint covariance of $(\hat{\beta}, \hat{\sigma}^2)$ through the closed-form recovery transform. The $(\hat{\beta}, \hat{\sigma}^2)$ block is treated as block-diagonal by the independence of sample mean and variance under normality. The variance of $\hat{\sigma}^2$ uses $2\sigma^4(N-m-1)/N^2$ for the MLE and $2\sigma^4/(N-m-1)$ when bias_correct = TRUE.

confint returns Wald intervals based on vcov.

Value

print and summary return object invisibly.

coef returns a named numeric vector.

fitted and residuals return numeric vectors.

vcov returns a $(m+2) \times (m+2)$ covariance matrix.

confint returns a two-column matrix of lower and upper bounds.

See Also

vasicekfit, predict.vasicekfit

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