Package 'svi'

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Type Package

Title SVI Implied Volatility Surface

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Description A package for fitting the option-implied volatility surface, computing the risk-neutral density distribution and risk-neutral moments based on the Stochastic Volatility Inspired (SVI) equation.

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Encoding UTF-8

LazyData true

Depends Matrix

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`axel` *Axel-Vogt Parameters*

Description

Loads the Axel-Vogt parameters, which are a typical example of arbitrage SVI surface.

Usage

```
axel()
```

Details

The paramters are given as:

$$-0.041, 0.1331, 0.306, 0.3586, 0.4153$$

corresponding to $(a, b, rho, m, sigma)$. When inspecting the Durrleman condition, one recognizes that this setting is not entirely positive.

Value

Loads the parameters `par` and shows the Durrleman/SVI plot.

Author(s)

Wolfgang Schadner

References

Schadner, W. (2023): Direct Fit for SVI Implied Volatilities

See Also

`svi`

Examples

```
## Not run
# axel()
```

`durrleman` *Durrleman Condition*

Description

Calculates the the Durrleman condition of arbitrage.

Usage

```
durrleman(x, par, Gs=FALSE)
```

Arguments

`x`	Vector of option's log moneyness. Preferably defined as $$x = log(\frac{strike\ price}{forward\ price})$$
`par`	Either the five SVI parameters (a, b, ρ, m, σ) or the conic coefficients z.
`Gs`	Returns additional values of $G_{1\pm}$ and G_2, see Martini and Mingone (2022) for details.

Details

The Durrleman function $g(x)$ should be positive across all x for an abritrage free volatility surface. If $g(x)$ is positive, then the risk-neutral density $q(x)$ is also positive. Let y be the implied variance for the moneyness x, then the durrleman function is defined as:

$$g(x) := (1 - \frac{xy'}{2y})^2 - \frac{y'^2}{4}(\frac{1}{y} + \frac{1}{4}) + \frac{y''}{2}$$

Alternatively, this might be expressed as:

$$g(x) = G_1(x) + \frac{1}{2\sigma}G_2(x)$$

(cp. Martini and Mingone (2022)).

Value

Returns the values g of the Durrleman function.

Author(s)

Wolfgang Schadner

References

Martini, C. and Mingone, A. (2022): *No Arbitrage SVI*, SIAM J. Financial Math., 13(1), pp. 227-261

See Also

svi

Examples

```
## Not run
# axel()
# g <- durrleman(x, par)
# plot(x, g); abline(h=0)
```

`geom` *Geometric Properties*

Description

Calculates the center and asymptotes of the SVI hyperbola.

Usage

```
geom(par)
```

Arguments

`par`	Either the five SVI parameters, or the six z coefficients defining the conic.

Details

Calculates the center and asymptotes of the SVI hyperbola.

Value

Returns the values of the Durrleman function.

Author(s)

Wolfgang Schadner

References

Schadner, W. (2023): Direct Fit for SVI Implied Volatilities

See Also

svi

Examples

```
## Not run
# load("sp500")
# df <- opt$`tau = 7 days`
# x <- df$k
# y <- df$ivol^2
# fit <- svifit(x, y)
# plot(x, y)
# lines(x, fit$yhat)
```

---

rnd *Risk-Neutral Density*

Description

Computes the risk-neutral density distribution for some SVI parameters `par`.

Usage

```
rnd(x, par)
```

Arguments

`x`	Vector of option's log moneyness. Preferably defined as $$x = log(\frac{strike\ price}{forward\ price})$$
`par`	Either the five SVI parameters (a, b, ρ, m, σ) or the conic coefficients z.

Value

Returns the risk-neutral density distribution.

Author(s)

Wolfgang Schadner

References

Schadner, W. (2023): Direct Fit for SVI Implied Volatilities

See Also

svi

Examples

```
## Not run
# axel()
# q <- rnd(x, par)
# plot(x, q)
```

---

rnmoment *Risk-Neutral Moments*

Description

Computes the risk-neutral variance (rnvar), skewness (rnskew), kurtosis (rnkurt) or more generally a moment of certain order (rnmoment) for the risk-neutral density distribution as specified by the SVI parameters par.

Usage

```
rnskew(par)
rnkurt(par)
rnmoment(par, order=2, absolute=FALSE, standardized=TRUE)
```

Arguments

par	either the five SVI parameters (a, b, ρ, m, σ) or the conic coefficients z.
order	order of the moment to be computed, the default is to compute the second moment, i.e., the variance.
absolute	a logical value indicating whether absolute moments are to be computed.
standardized	a logical value indicating whether standardized moments are to be computed.

Value

Returns the risk-neutral moment.

Author(s)

Wolfgang Schadner

References

Schadner, W. (2023): Direct Fit for SVI Implied Volatilities

See Also

svi, rnd

Examples

```
## Not run
# data(sp500)
# df <- sp500$`tau = 7 days`
# x <- df$k
# y <- df$ivol^2
# mdl <- svifit(x,y)
# rnskew(mdl$par)
# rnmoment(mdl$par)
```

---

sp500 *Example options of the S&P 500*

Description

This data set covers option data for the S&P 500 as observed on ....

Usage

```
data(sp500)
```

Format

A list of the options with different maturities and strikes.

Source

OptionMetrics.

References

...

---

svi *Calculate SVI predicted values*

Description

Calculates the y values as predicted by SVI for some given x and parameter set.

Usage

```
svi(x, par)
```

Arguments

x	Values of forward log moneyness. I.e., log(strike/forward).
par	Either the five SVI parameters, or the six z coefficients defining the conic.

Details

...

Value

Returns the predicted y values.

Author(s)

Wolfgang Schadner

References

Schadner, W. (2023): Direct Fit for SVI Implied Volatilities

See Also

svipar

Examples

```
## Not run
# load("sp500")
# df <- opt$`tau = 7 days`
# x <- df$k
# y <- df$ivol^2
# fit <- svifit(x, y)
# plot(x, y)
# lines(x, fit$yhat)
```

---

svifit *Fitting SVI volatilities*

Description

Fits the Stochastic Volatility Inspired (SVI) equation to an implied volatility surface of given maturity. The input variable x represents the log-moneyness (logarithm of strike over forward-price) and y the implied variance (implied volatility squared).

Usage

```
svifit(x, y, fit="direct", na.rm=TRUE, low_ecc=TRUE, W=NA, a=NA, init=c(0, 0.2))
```

Arguments

x	Vector of option's log moneyness. Preferably defined as $$x = log(\frac{strike\ price}{forward\ price})$$
y	Vector of implied variances corresponding to x. That is, the squared implied volatilities over x.
fit	Fitting method to be used. Possible vbalues are: • direct: direct least-squares • direct_UC: direct unconstrained least-squares • vanish: vanishing wings, i.e. flat extrapolation • QE: quasi-explicit fit, i.e. iterative routine
na.rm	Removing NA's
low_ecc	Correction for the low eccentricity bias.
W	(optional) Weighting vector for a weighted least-squares.
a	(optional) For vanish fit: specify the y-level for the flat extrapolation.
init	(optional) For QE fit: Starting values of m and σ.

Details

The method is implemented as described by Schadner (2023).

Value

Returns a list of the following:

yhat	Fitted y values.
par	The SVI parameters a, b, ρ, m, σ.
z	The conic coefficients defining the hyperbola.
input	The input data.

Author(s)

Wolfgang Schadner

References

Schadner, W. (2023): Direct Fit for SVI Implied Volatilities

See Also

svipar

Examples

```
## Not run
# library(svi)
# data(sp500)
# df <- sp500$`tau = 7 days`
# x <- df$k
# y <- df$ivol^2
# fit <- svifit(x, y)
# plot(x, y)
# lines(x, fit$yhat)
#
# # Risk-Neutral Density:
# q <- rnd(x, fit$par)
# plot(x, q)
```

`svipar` *Translating conic coefficients into SVI parameters, and vice versa*

Description

This function transforms the 6 conic coefficients z into the 5 SVI paramters, or other way around.

Usage

```
svipar(par)
```

Arguments

`par`	Either the six conic coefficients z, or the 5 SVI paramters: $(ab\rho m\sigma)$.

Details

A conic is generally defined as:

$$0 = Dz$$

for the coefficients z and the design matrix D

$$D = (x^2 xy y^2 xy 1)$$

. There exists a direct mapping between z and the 5 SVI parameters, see Schadner 2023.

Value

Returns either the five SVI paramters:

$$par = (ab\rho m\sigma)$$

Or the z coefficients.

Author(s)

Wolfgang Schadner

References

Schadner, W. (2023): Direct Fit for SVI Implied Volatilities

See Also

svipar

Examples

```
## Not run
# TBD
```

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