Package ‘highfrequencyGSOC’

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Type Package

Title What the package does (short line)

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Description Additional functionality for the highfrequency package: jump test, standard error

License GPL

Depends highfrequency

R topics documented:

highfrequencyGSOC-package   *Additional functionality for the highfrequency package*

Description

Additional functionality for the highfrequency package: jump test, standard error

Details

Package:	highfrequencyGSOC
Type:	Package
Version:	1.0
Date:	2013-07-02
License:	GPL

~~ An overview of how to use the package, including the most important functions ~~

Author(s)

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AJjumptest   *Ait- Sahalia and Jacod (2009) tests for the presence of jumps in the price series.*

Description

This test examines the presence of jumps in highfrequency price series. It is based on the theory of Ait-Sahalia and Jacod (2009) (AJ). It consists in comparing the multipower variation of equispaced returns computed at a fast time scale (h), $r_{t,i}$ ($i = 1, \ldots, N$) and those computed at the slower time scale (kh), $y_{t,i}(i = 1, \ldots,$ N/k).

They found that the limit (for $N \to \infty$) of the realized power variation is invariant for different sampling scales and that their ratio is 1 in case of jumps and k$^{p/2} - 1$ if no jumps. Therefore the AJ test detects the presence of jump using the ratio of realized power variation sampled from two scales. The null hypothesis is no jumps.

Function returns three outcomes: 1.z-test value 2.critical value under confidence level of 95% and 3.p-value.

Assume there is N equispaced returns in period t. Let $r_{t,i}$ be a return (with $i = 1, \ldots, N$) in period t.

And there is N/k equispaced returns in period t. Let $y_{t,i}$ be a return (with $i = 1, \ldots,$ N/k) in period t.

Then the AJjumptest is given by:

$$\text{AJjumptest}_{t,N} = \frac{S_t(p,k,h) - k^{p/2-1}}{\sqrt{V_{t,N}}}$$

in which,

$$\text{S}_t(p,k,h) = \frac{PV_{t,M}(p,kh)}{PV_{t,M}(p,h)}$$

$$\text{PV}_{t,N}(p,kh) = \sum_{i=1}^{N/k} |y_{t,i}|^p$$

$$\text{PV}_{t,N}(p,h) = \sum_{i=1}^{N} |r_{t,i}|^p$$

$$\text{V}_{t,N} = \frac{N(p,k)A_{t,N(2p)}}{NA_{t,N(p)}}$$

$$\text{N}(p,k) = \left(\frac{1}{\mu_p^2}\right)(k^{p-2}(1+k))\mu_{2p} + k^{p-2}(k-1)\mu_p^2 - 2k^{p/2-1}\mu_{k,p}$$

$$\text{A}_{t,n(2p)} = \frac{(1/N)^{(1-p/2)}}{\mu_p} \sum_{i=1}^{N} |r_{t,i}|^p \text{ for } |r_j| < \alpha(1/N)^w$$

$$\mu_{k,p} = E(|U|^p|U + \sqrt{k-1}V|^p)$$

U, V: independent standard normal random variables; $h = 1/N$; p, k, α, w: parameters.

Usage

AJjumptest(pdata, p=4 , k=2, align.by= NULL, align.period = NULL, makeReturns= FALSE, ...)

Arguments

pdata	a zoo/xts object containing all prices in period t for one asset.
p	can be chosen among 2 or 3 or 4. The author suggests 4. 4 by default.
k	can be chosen among 2 or 3 or 4. The author suggests 2. 2 by default.
align.by	a string, align the tick data to "seconds"|"minutes"|"hours"
align.period	an integer, align the tick data to this many [seconds|minutes|hours].
makeReturns	boolean, should be TRUE when rdata contains prices instead of returns. FALSE by default.
...	additional arguments.

Details

The theoretical framework underlying jump test is that the logarithmic price process X_t belongs to the class of Brownian semimartingales, which can be written as:

$$\mathrm{X}_t = \int_0^t a_u du + \int_0^t \sigma_u dW_u + Z_t$$

where a is the drift term, σ denotes the spot volatility process, W is a standard Brownian motion and Z is a jump process defined by:

$$\mathrm{Z}_t = \sum_{j=1}^{N_t} k_j$$

where k_j are nonzero random variables. The counting process can be either finite or infinite for finite or infinite activity jumps.

The Ait-Sahalia and Jacod test is that: Using the convergence properties of power variation and its dependence on the time scale on which it is measured, Ait-Sahalia and Jacod (2009) define a new variable which converges to 1 in the presence of jumps in the underlying return series, or to another deterministic and known number in the absence of jumps. (Theodosiou& Zikes(2009))

Value

list

Author(s)

Giang Nguyen, Jonathan Cornelissen and Kris Boudt

References

Ait-Sahalia, Y. and Jacod, J. (2009). Testing for jumps in a discretely observed process. The Annals of Statistics, 37(1), 184- 222.

Theodosiou, M., & Zikes, F. (2009). A comprehensive comparison of alternative tests for jumps in asset prices. Unpublished manuscript, Graduate School of Business, Imperial College London.

Examples

```
data(sample_tdata)
AJjumptest(sample_tdata$PRICE, p= 2, k= 3, align.by= "seconds", align.period= 5, makeReturns= TRUE)
```

BNSjumptest *Barndorff- Nielsen and Shephard (2006) tests for the presence of jumps in the price series.*

Description

This test examines the presence of jumps in highfrequency price series. It is based on theory of Barndorff- Nielsen and Shephard (BNS). The null hypothesis is no jumps. Depending on users' choices of estimator (integrated variance (IVestimator), integrated quarticity (IQestimator)), mechanism (linear, ratio) and adjustment (logarith), the function returns the result. Function returns three outcomes: 1.z-test value 2.critical value(with confidence level of 95%) and 3.pvalue of the test.

Assume there is N equispaced returns in period t.

Assume the Realized variance (RV), IVestimator and IQestimator are based on N equispaced returns.

Let $r_{t,i}$ be a return (with $i = 1, \ldots, N$) in period t.

Then the BNSjumptest is given by:

$$\text{BNSjumptest} = \frac{RV - IVestimator}{\sqrt{(\theta - 2)\frac{1}{N} IQestimator}}$$

in which, $IVestimator$ can be: bipower variance (BV), minRV, medRV. $IQestimator$ can be: tripower quarticity (TP), quadpower quarticity (QP), minRQ, medRQ.

θ: depends on IVestimator. (Huang and Tauchen (2005))

Usage

```
BNSjumptest(rdata, IVestimator= "BV", IQestimator= "TP", type= "linear", logtransform= FALSE,
      max= FALSE, align.by= NULL, align.period= NULL, makeReturns = FALSE, startV= NULL,...)
```

Arguments

rdata	a zoo/xts object containing all returns in period t for one asset.
IVestimator	can be chosen among jump robust integrated variance estimators: BV, minRV, medRV and corrected threshold bipower variation (CTBV). BV by default.
IQestimator	can be chosen among jump robust integrated quarticity estimators: TP, QP, minRQ and medRQ. TP by default.
type	a method of BNS testing: can be linear or ratio. Linear by default.
logtransform	boolean, should be TRUE when QVestimator and IVestimator are in logarith form. FALSE by default.
max	boolean, should be TRUE when max adjustment in SE. FALSE by default.
align.by	a string, align the tick data to "seconds"|"minutes"|"hours"
align.period	an integer, align the tick data to this many [seconds|minutes|hours].
makeReturns	boolean, should be TRUE when rdata contains prices instead of returns. FALSE by default.
startV	start point of auxiliary estimators in threshold estimation (Corsi et al. (2010). NULL by default.
...	additional arguments.

Details

The theoretical framework underlying jump test is that the logarithmic price process X_t belongs to the class of Brownian semimartingales, which can be written as:

$$\mathrm{X}_t = \int_0^t a_u du + \int_0^t \sigma_u dW_u + Z_t$$

where a is the drift term, σ denotes the spot volatility process, W is a standard Brownian motion and Z is a jump process defined by:

$$\mathrm{Z}_t = \sum_{j=1}^{N_t} k_j$$

where k_j are nonzero random variables. The counting process can be either finite or infinite for finite or infinite activity jumps.

Since the realized volatility converges to the sum of integrated variance and jump variation, while the robust IVestimator converges to the integrated variance, it follows that the difference between $RV_{t,N}$ and the IVestimator captures the jump part only, and this observation underlines the BNS test for jumps. (Theodosiou& Zikes(2009))

Value

list

Author(s)

Giang Nguyen, Jonathan Cornelissen and Kris Boudt

References

Barndorff-Nielsen, O. E., & Shephard, N. (2006). Econometrics of testing for jumps in financial economics using bipower variation. Journal of financial Econometrics, 4(1), 1-30.

Corsi, F., Pirino, D., & Reno, R. (2010). Threshold bipower variation and the impact of jumps on volatility forecasting. Journal of Econometrics, 159(2), 276-288.

Huang, X., & Tauchen, G. (2005). The relative contribution of jumps to total price variance. Journal of financial econometrics, 3(4), 456-499.

Theodosiou, M., & Zikes, F. (2009). A comprehensive comparison of alternative tests for jumps in asset prices. Unpublished manuscript, Graduate School of Business, Imperial College London.

Examples

```
data(sample_tdata)
BNSjumptest(sample_tdata$PRICE, QVestimator= "RV", IVestimator= "minRV",
         IQestimator = "medRQ", type= "linear", makeReturns = TRUE)
```

---

ivInference — *Function returns the value, the standard error and the confidence band of the integrated variance (IV) estimator.*

Description

This function supplies information about standard error and confidence band of integrated variance (IV) estimators under Brownian semimartingales model such as: bipower variation, minRV, medRV. Depending on users' choices of estimator (integrated variance (IVestimator), integrated quarticity (IQestimator)) and confidence level, the function returns the result.(Barndorff (2002)) Function returns three outcomes: 1.value of IV estimator 2.standard error of IV estimator and 3.confidence band of IV estimator.

Assume there is N equispaced returns in period t.

Then the ivInference is given by:

$$\text{standard error} = \frac{1}{\sqrt{N}} * sd$$

$$\text{confidence band} = \hat{IV} \pm cv * se$$

in which,

$$\text{sd} = \sqrt{\theta \times \hat{IQ}}$$

cv : critical value.

se : standard error.

θ : depending on IQestimator, θ can take different value (Andersen et al. (2012)).

$\hat{IQ}$ integrated quarticity estimator.

Usage

```
ivInference (rdata, IVestimator="RV", IQestimator="rQuar", confidence=0.95,
        align.by= NULL, align.period = NULL, makeReturns = FALSE, ...)
```

Arguments

rdata	a zoo/xts object containing all returns in period t for one asset.
IVestimator	can be chosen among integrated variance estimators: RV, BV, minRV or medRV. RV by default.
IQestimator	can be chosen among integrated quarticity estimators: rQuar, TP, QP, minRQ or medRQ. rQuar by default.
confidence	confidence level set by users. 0.95 by default.
align.by	a string, align the tick data to "seconds"|"minutes"|"hours"
align.period	an integer, align the tick data to this many [seconds|minutes|hours].
makeReturns	boolean, should be TRUE when rdata contains prices instead of returns. FALSE by default.
...	additional arguments.

Details

The theoretical framework is the logarithmic price process X_t belongs to the class of Brownian semimartingales, which can be written as:

$$\text{X}_t = \int_0^t a_u du + \int_0^t \sigma_u dW_u$$

where a is the drift term, σ denotes the spot volatility process, W is a standard Brownian motion (assume that there are no jumps).

Value

list

Author(s)

Giang Nguyen, Jonathan Cornelissen and Kris Boudt

References

Andersen, T. G., D. Dobrev, and E. Schaumburg (2012). Jump-robust volatility estimation using nearest neighbor truncation. Journal of Econometrics, 169(1), 75- 93.

Barndorff-Nielsen, O. E. (2002). Econometric analysis of realized volatility and its use in estimating stochastic volatility models. Journal of the Royal Statistical Society: Series B (Statistical Methodology), 64(2), 253-280.

Examples

```
data(sample_tdata)
ivInference(sample_tdata$PRICE, IVestimator= "minRV", IQestimator= "medRQ",
        confidence=0.95, makeReturns = TRUE)
```

JOjumptest *Jiang and Oomen (2008) tests for the presence of jumps in the price series.*

Description

This test examines the jump in highfrequency data. It is based on theory of Jiang and Oomen (JO). They found that the difference of simple return and logarithmic return can capture one half of integrated variance if there is no jump in the underlying sample path. The null hypothesis is no jumps.

Function returns three outcomes: 1.z-test value 2.critical value under confidence level of 95% and 3.p-value.

Assume there is N equispaced returns in period t.

Let $r_{t,i}$ be a logarithmic return (with $i = 1, \ldots, N$) in period t.

Let $R_{t,i}$ be a simple return (with $i = 1, \ldots, N$) in period t.

Then the JOjumptest is given by:

$$\text{JOjumptest}_{t,N} = \frac{NBV_t}{\sqrt{\Omega_{SwV}}\left(1 - \frac{RV_t}{SwV_t}\right)}$$

in which, BV: bipower variance; RV: realized variance (defined by Andersen et al. (2012));

$$\text{SwV}_t = 2\sum_{i=1}^{N}(R_{t,i} - r_{t,i})$$

$$\Omega_{SwV} = \frac{\mu_6}{9}\frac{N^3\mu_{6/p}^{-p}}{N-p-1}\sum_{i=0}^{N-p}\prod_{k=1}^{p}|r_{t,i+k}|^{6/p}$$

$$\mu_p = \text{E}[|\text{U}|^p] = 2^{p/2}\frac{\Gamma(1/2(p+1))}{\Gamma(1/2)}$$

U: independent standard normal random variables

p: parameter (power).

Usage

```
JOjumptest(pdata, power=4,...)
```

Arguments

pdata	a zoo/xts object containing all prices in period t for one asset.
power	can be chosen among 4 or 6. 4 by default.
...	additional arguments.

Details

The theoretical framework underlying jump test is that the logarithmic price process X_t belongs to the class of Brownian semimartingales, which can be written as:

$$\mathrm{X}_t = \int_0^t a_u du + \int_0^t \sigma_u dW_u + Z_t$$

where a is the drift term, σ denotes the spot volatility process, W is a standard Brownian motion and Z is a jump process defined by:

$$\mathrm{Z}_t = \sum_{j=1}^{N_t} k_j$$

where k_j are nonzero random variables. The counting process can be either finite or infinite for finite or infinite activity jumps.

The Jiang and Oomen test is that: in the absence of jumps, the accumulated difference between the simple return and the log return captures one half of the integrated variance.(Theodosiou& Zikes(2009))

Value

list

Author(s)

Giang Nguyen, Jonathan Cornelissen and Kris Boudt

References

Andersen, T. G., D. Dobrev, and E. Schaumburg (2012). Jump-robust volatility estimation using nearest neighbor truncation. Journal of Econometrics, 169(1), 75- 93.

Jiang, J.G. and Oomen R.C.A (2008). Testing for jumps when asset prices are observed with noise-a "swap variance" approach. Journal of Econometrics,144(2), 352-370.

Theodosiou, M., & Zikes, F. (2009). A comprehensive comparison of alternative tests for jumps in asset prices. Unpublished manuscript, Graduate School of Business, Imperial College London.

Examples

```
data(sample_5minprices_jumps)
JOjumptest(sample_5minprices_jumps[,1], power= 6)
```

---

medRQ — *An estimator of integrated quarticity from applying the median operator on blocks of three returns.*

Description

Function returns the medRQ, defined in Andersen et al. (2012).

Assume there is N equispaced returns in period t. Let $r_{t,i}$ be a return (with $i = 1, \ldots, N$) in period t.

Then, the medRQ is given by

$$\mathrm{medRQ}_t = \frac{3\pi N}{9\pi + 72 - 52\sqrt{3}} \left(\frac{N}{N-2}\right) \sum_{i=2}^{N-1} \mathrm{med}(|r_{t,i-1}|, |r_{t,i}|, |r_{t,i+1}|)^4$$

Usage

```
medRQ (rdata, align.by=NULL, align.period=NULL, makeReturns=FALSE,...)
```

Arguments

rdata	a zoo/xts object containing all returns in period t for one asset.
align.by	a string, align the tick data to "seconds"|"minutes"|"hours"
align.period	an integer, align the tick data to this many [seconds|minutes|hours].
makeReturns	boolean, should be TRUE when rdata contains prices instead of returns. FALSE by default.
...	additional arguments.

Value

numeric

Author(s)

Giang Nguyen, Jonathan Cornelissen and Kris Boudt

References

Andersen, T. G., D. Dobrev, and E. Schaumburg (2012). Jump-robust volatility estimation using nearest neighbor truncation. Journal of Econometrics, 169(1), 75- 93.

Examples

```
data(sample_tdata)
medRQ(rdata= sample_tdata$PRICE, align.by= "minutes", align.period =5, makeReturns= TRUE)
medRQ
```

minRQ — *An estimator of integrated quarticity from applying the minimum operator on blocks of two returns.*

Description

Function returns the minRQ, defined in Andersen et al. (2012).

Assume there is N equispaced returns in period t. Let $r_{t,i}$ be a return (with $i = 1, \ldots, N$) in period t.

Then, the minRQ is given by

$$\mbox{minRQ}_{t} = \frac{\pi N}{3\pi - 8}\left(\frac{N}{N-1}\right)\sum_{i=1}^{N-1}\mbox{min}(|r_{t,i}|,|r_{t,i+1}|)^4$$

Usage

```
minRQ (rdata,align.by=NULL,align.period=NULL,makeReturns=FALSE,...)
```

Arguments

rdata	a zoo/xts object containing all returns in period t for one asset.
align.by	a string, align the tick data to "seconds"|"minutes"|"hours"
align.period	an integer, align the tick data to this many [seconds|minutes|hours].
makeReturns	boolean, should be TRUE when rdata contains prices instead of returns. FALSE by default.
...	additional arguments.

Value

numeric

Author(s)

Giang Nguyen, Jonathan Cornelissen and Kris Boudt

References

Andersen, T. G., D. Dobrev, and E. Schaumburg (2012). Jump-robust volatility estimation using nearest neighbor truncation. Journal of Econometrics, 169(1), 75- 93.

Examples

```
data(sample_tdata)
minRQ(rdata= sample_tdata$PRICE, align.by= "minutes", align.period =5, makeReturns= TRUE)
minRQ
```

MRC — *Modulated Realized Covariance (MRC): Return univariate or multivariate preaveraged estimator.*

Description

Function returns univariate or multivariate preaveraged estimator, as difined in Hautsch & Podolskij (2013).

Usage

MRC= function(pdata, pairwise=FALSE,makePsd= FALSE,...)

Arguments

pdata	a list. Each list-item contains an xts object with the intraday price data of a stock.
pairwise	boolean, should be TRUE when refresh times are based on pairs of assets. FALSE by default.
makePsd	boolean, in case it is TRUE, the positive definite version of MRC is returned. FALSE by default.
...	additional arguments.

Details

In practice, market microstructure noise leads to a departure from the pure semimartingale model. We consider the process Y in period τ:

$$\mathrm{Y}_\tau = X_\tau + \epsilon_\tau$$

where, the observed d dimensional log-prices are the sum of underlying Brownian semimartingale process X and a noise term ϵ_τ.

ϵ_τ is an i.i.d process with X.

It is intuitive that under mean zero i.i.d. microstructure noise some form of smoothing of the observed log-price should tend to diminish the impact of the noise. Effectively, we are going to approximate a continuous function by an average of observations of Y in a neighborhood, the noise being averaged away.

Assume there is N equispaced returns in period τ of a list (after refeshing data). Let r_{τ_i} be a return (with $i = 1, \ldots, N$) of an asset in period τ. Assume there is d assets.

In order to define the univariate pre-averaging estimator, we first define the pre-averaged returns as

$$\bar{r}_{\tau_j}^{(k)} = \sum_{h=1}^{k_N-1} g\left(\frac{h}{k_N}\right) r_{\tau_{j+h}}^{(k)}$$

where g is a non-zero real-valued function $g : [0,1] \to R$ given by $g(x)$ = $\min(x, 1-x)$. k_N is a sequence of integers satisfying $\mathrm{k}_N = \lfloor \theta N^{1/2} \rfloor$. We use $\theta = 0.8$ as recommendations in (Hautsch & Podolskij (2013)). The pre-averaged returns are simply a weighted average over the returns in a local window. This averaging diminishes the influence of the noise. The order of the window size k_n is chosen to lead to optimal convergence rates. The pre-averaging estimator is then simply the analogue of the Realized Variance but based on pre-averaged returns and an additional term to remove bias due to noise

$$\hat{C} = \frac{N^{-1/2}}{\theta\psi_2} \sum_{i=0}^{N-k_N+1} (\bar{r}_{\tau_i})^2 - \frac{\psi_1^{k_N} N^{-1}}{2\theta^2 \psi_2^{k_N}} \sum_{i=0}^{N} r_{\tau_i}^2$$

with

$$\psi_1^{k_N} = k_N \sum_{j=1}^{k_N} \left(g\left(\frac{j+1}{k_N}\right) - g\left(\frac{j}{k_N}\right) \right)^2,$$

$$\psi_2^{k_N} = \frac{1}{k_N} \sum_{j=1}^{k_N-1} g^2\left(\frac{j}{k_N}\right).$$

$$\psi_2 = \frac{1}{12}$$

The multivariate counterpart is very similar. The estimator is called the Modulated Realized Covariance (MRC) and is defined as

$$\text{MRC} = \frac{N}{N - k_N + 2} \frac{1}{\psi_2 k_N} \sum_{i=0}^{N-k_N+1} \bar{\boldsymbol{r}}_{\tau_i} \cdot \bar{\boldsymbol{r}}'_{\tau_i} - \frac{\psi_1^{k_N}}{\theta^2 \psi_2^{k_N}} \hat{\Psi}$$

where $\hat{\Psi}_N = \frac{1}{2N} \sum_{i=1}^{N} \boldsymbol{r}_{\tau_i} (\boldsymbol{r}_{\tau_i})'$. It is a bias correction to make it consistent. However, due to this correction, the estimator is not ensured PSD. An alternative is to slightly enlarge the bandwidth such that $\text{k}_N = \lfloor \theta N^{1/2+\delta} \rfloor$. $\delta = 0.1$ results in a consistent estimate without the bias correction and a PSD estimate, in which case:

$$\text{MRC}^{\delta} = \frac{N}{N - k_N + 2} \frac{1}{\psi_2 k_N} \sum_{i=0}^{N-k_N+1} \bar{\boldsymbol{r}}_i \cdot \bar{\boldsymbol{r}}'_i$$

Value

an dxd matrix

Author(s)

Giang Nguyen, Jonathan Cornelissen and Kris Boudt

References

Hautsch, N., & Podolskij, M. (2013). Preaveraging-Based Estimation of Quadratic Variation in the Presence of Noise and Jumps: Theory, Implementation, and Empirical Evidence. Journal of Business & Economic Statistics, 31(2), 165-183.

Examples

```
data(sample_5minprices_jumps)
a= list (sample_5minprices_jumps["2010-01-04",1],
        sample_5minprices_jumps["2010-01-04",2] )
MRC(a, pairwise=TRUE,makePsd=TRUE)
```

rBeta	*Realized beta: a tool in measuring risk with respect to the market.*

Description

Depending on users' choices of estimator (realized covariance (RCOVestimator) and realized variance (RVestimator)), the function returns the realized beta, defined as the ratio between both.

The realized beta is given by

$$\beta_{jm} = \frac{RCOVestimator_{jm}}{RVestimator_{m}}$$

in which

$RCOVestimator$: Realized covariance of asset j and market index m.

$RVestimator$: Realized variance of market index m.

Usage

```
rBeta= function(rdata, rindex, RCOVestimator= "rCov", RVestimator= "RV",
         makeReturns= FALSE,...)
```

Arguments

rdata	a zoo/xts object containing all returns in period t for one asset.
rindex	a zoo/xts object containing return in period t for an index.
RCOVestimator	can be chosen among realized covariance estimators: rCov, rAVGCov, rBPCov, rHYCov, rKernelCov, rOWCov, rRTSCov, rThresholdCov and rTSCov. rCov by default.
RVestimator	can be chosen among realized variance estimators: RV, minRV and medRV. RV by default. In case of missing RVestimator, RCOVestimator function applying for rindex will be used.
makeReturns	boolean, should be TRUE when rdata contains prices instead of returns. FALSE by default.
...	additional arguments.

Details

Suppose there are N equispaced returns on day t for the asset j and the index m. Denote $r_{(j)i,t}$, $r_{(m)i,t}$ as the ith return on day t for asset j and index m (with $i = 1, \ldots, N$).

By default, the RCov is used and the realized beta coefficient is computed as:

$$\hat{\beta}_{(jm)t} = \frac{\sum_{i=1}^{N} r_{(j)i,t} r_{(m)i,t}}{\sum_{i=1}^{N} r_{(m)i,t}^2}$$

(Barndorff & Shephard (2004)).

Note: It is worth to note that the function does not support to calculate for data of multiple days.

Value

numeric

Author(s)

Giang Nguyen, Jonathan Cornelissen and Kris Boudt

References

Barndorff-Nielsen, O. E., & Shephard, N. (2004). Econometric analysis of realized covariation: High frequency based covariance, regression, and correlation in financial economics. Econometrica, 72(3), 885-925.

Examples

```
data(sample_5minprices_jumps)
a=sample_5minprices_jumps['2010-01-04',1]
b=sample_5minprices_jumps['2010-01-04',2]

rBeta(a,b,RCOVestimator="rBPCov",RVestimator="minRV",makeReturns=TRUE)
```

---

rKurt *Realized kurtosis of highfrequency return series.*

Description

Function returns Realized kurtosis, defined in Amaya et al. (2011).

Assume there is N equispaced returns in period t. Let $r_{t,i}$ be a return (with $i = 1, \ldots, N$) in period t.

Then, the rKurt is given by

$$\text{rKurt}_t = \frac{N \sum_{i=1}^{N} (r_{t,i})^4}{RV_t^2}$$

in which RV_t : realized variance

Usage

```
rKurt (rdata,align.by=NULL,align.period=NULL,makeReturns=FALSE,...)
```

Arguments

rdata	a zoo/xts object containing all returns in period t for one asset.
align.by	a string, align the tick data to "seconds"|"minutes"|"hours"
align.period	an integer, align the tick data to this many [seconds|minutes|hours].
makeReturns	boolean, should be TRUE when rdata contains prices instead of returns. FALSE by default.
...	additional arguments.

Value

numeric

Author(s)

Giang Nguyen, Jonathan Cornelissen and Kris Boudt

References

Amaya, D., Christoffersen, P., Jacobs, K. and Vasquez, A. (2011). Do realized skewness and kurtosis predict the cross-section of equity returns?. CREATES research paper. p. 3-7.

Examples

```
data(sample_tdata)
rKurt(sample_tdata$PRICE,align.by ="minutes", align.period =5, makeReturns = TRUE)
```

---

rMPV *Realized multipower variation (MPV), an estimator of integrated power variation.*

Description

Function returns the rMPV, defined in Andersen et al. (2012).

Assume there is N equispaced returns in period t. Let $r_{t,i}$ be a return (with $i = 1, \ldots, N$) in period t.

Then, the rMPV is given by

$$\text{rMPV}_N(m,p) = d_{m,p} \frac{N^{p/2}}{N-m+1} \sum_{i=1}^{N-m+1} |r_{t,i}|^{p/m} \ldots |r_{t,i+m-1}|^{p/m}$$

in which

$d_{m,p} = \mu_{p/m}^{-m}$:

m: the window size of return blocks;

p: the power of the variation;

and m > $p/2$.

Usage

```
rMPV= function(rdata, m= 2, p=2, align.by= NULL, align.period= NULL, makeReturns= FALSE,...)
```

Arguments

rdata	a zoo/xts object containing all returns in period t for one asset.
m	the window size of return blocks. 2 by default.
p	the power of the variation. 2 by default.
align.by	a string, align the tick data to "seconds"|"minutes"|"hours"
align.period	an integer, align the tick data to this many [seconds|minutes|hours].
makeReturns	boolean, should be TRUE when rdata contains prices instead of returns. FALSE by default.
...	additional arguments.

Value

numeric

Author(s)

Giang Nguyen, Jonathan Cornelissen and Kris Boudt

References

Andersen, T. G., D. Dobrev, and E. Schaumburg (2012). Jump-robust volatility estimation using nearest neighbor truncation. Journal of Econometrics, 169(1), 75- 93.

Examples

```
data(sample_tdata)
rMPV(sample_tdata$PRICE, m=2, p=3, align.by= "minutes", align.period=5,makeReturns= TRUE)
```

---

rQPVar — *Realized quadpower variation of highfrequency return series.*

Description

Function returns the rQPVar, defined in Andersen et al. (2012).

Assume there is N equispaced returns in period t. Let $r_{t,i}$ be a return (with $i = 1, \ldots, N$) in period t.

Then, the rQPVar is given by

$$\text{rQPVar}_t = \frac{N}{N-3} \frac{\pi^2}{4} \sum_{i=4}^{N} (|r_{t,i}||r_{t,i-1}||r_{t,i-2}||r_{t,i-3}|)$$

Usage

```
rQPVar (rdata, align.by=NULL, align.period=NULL, makeReturns=FALSE,...)
```

Arguments

rdata	a zoo/xts object containing all returns in period t for one asset.
align.by	a string, align the tick data to "seconds"|"minutes"|"hours"
align.period	an integer, align the tick data to this many [seconds|minutes|hours].
makeReturns	boolean, should be TRUE when rdata contains prices instead of returns. FALSE by default.
...	additional arguments.

Value

numeric

Author(s)

Giang Nguyen, Jonathan Cornelissen and Kris Boudt

References

Andersen, T. G., D. Dobrev, and E. Schaumburg (2012). Jump-robust volatility estimation using nearest neighbor truncation. Journal of Econometrics, 169(1), 75- 93.

Examples

```
data(sample_tdata)
rQPVar(rdata= sample_tdata$PRICE, align.by= "minutes", align.period =5, makeReturns= TRUE)
rQPVar
```

---

rQuar *Realized quarticity of highfrequency return series.*

Description

Function returns the rQuar, defined in Andersen et al. (2012).

Assume there is N equispaced returns in period t. Let $r_{t,i}$ be a return (with $i = 1, \ldots, N$) in period t.

Then, the rQuar is given by

$$\text{rQuar}_t = \frac{N}{3} \sum_{i=1}^{N} (r_{t,i}^4)$$

Usage

```
rQuar (rdata, align.by=NULL, align.period=NULL, makeReturns=FALSE,...)
```

Arguments

rdata	a zoo/xts object containing all returns in period t for one asset.
align.by	a string, align the tick data to "seconds"|"minutes"|"hours"
align.period	an integer, align the tick data to this many [seconds|minutes|hours].
makeReturns	boolean, should be TRUE when rdata contains prices instead of returns. FALSE by default.
...	additional arguments.

Value

numeric

Author(s)

Giang Nguyen, Jonathan Cornelissen and Kris Boudt

References

Andersen, T. G., D. Dobrev, and E. Schaumburg (2012). Jump-robust volatility estimation using nearest neighbor truncation. Journal of Econometrics, 169(1), 75- 93.

Examples

```
data(sample_tdata)
rQuar(rdata= sample_tdata$PRICE, align.by= "minutes", align.period =5, makeReturns= TRUE)
rQuar
```

---

rSkew *Realized skewness of highfrequency return series.*

Description

Function returns Realized skewness, defined in Amaya et al. (2011).

Assume there is N equispaced returns in period t. Let $r_{t,i}$ be a return (with $i = 1, \ldots, N$) in period t.

Then, the rSkew is given by

$$\text{rSkew}_t = \frac{\sqrt{N}\sum_{i=1}^{N}(r_{t,i})^3}{RV_t^{3/2}}$$

in which RV_t : realized variance

Usage

```
rSkew (rdata,align.by=NULL,align.period=NULL,makeReturns=FALSE,...)
```

Arguments

rdata	a zoo/xts object containing all returns in period t for one asset.
align.by	a string, align the tick data to "seconds"|"minutes"|"hours"
align.period	an integer, align the tick data to this many [seconds|minutes|hours].
makeReturns	boolean, should be TRUE when rdata contains prices instead of returns. FALSE by default.
...	additional arguments.

Value

numeric

Author(s)

Giang Nguyen, Jonathan Cornelissen and Kris Boudt

References

Amaya, D., Christoffersen, P., Jacobs, K. and Vasquez, A. (2011). Do realized skewness and kurtosis predict the cross-section of equity returns?. CREATES research paper. p. 3-7.

Examples

```
data(sample_tdata)
rSkew(sample_tdata$PRICE,align.by ="minutes", align.period =5, makeReturns = TRUE)
```

rSV *Realized semivariance of highfrequency return series.*

Description

Function returns Realized semivariance, defined in Barndorff-Nielsen et al. (2008).

Function returns two outcomes: 1.Downside realized semivariance and 2.Upside realized semivariance.

Assume there is N equispaced returns in period t. Let $r_{t,i}$ be a return (with $i = 1, \ldots, N$) in period t.

Then, the rSV is given by

$$\text{rSVdownside}_t = \sum_{i=1}^{N} (r_{t,i})^2 \; \times \; I[r_{t,i} < 0]$$

$$\text{rSVupside}_t = \sum_{i=1}^{N} (r_{t,i})^2 \; \times \; I[r_{t,i} > 0]$$

Usage

```
rSV (rdata,align.by=NULL,align.period=NULL,makeReturns=FALSE,...)
```

Arguments

rdata	a zoo/xts object containing all returns in period t for one asset.
align.by	a string, align the tick data to "seconds"|"minutes"|"hours"
align.period	an integer, align the tick data to this many [seconds|minutes|hours].
makeReturns	boolean, should be TRUE when rdata contains prices instead of returns. FALSE by default.
...	additional arguments.

Value

list

Author(s)

Giang Nguyen, Jonathan Cornelissen and Kris Boudt

References

Barndorff- Nielsen, O.E., Kinnebrock, S. and Shephard N. (2008). Measuring downside risk- realized semivariance. CREATES research paper. p. 3-5

Examples

```
data(sample_tdata)
rSV(sample_tdata$PRICE,align.by ="minutes", align.period =5, makeReturns = TRUE)
```

rTPVar *Realized tripower variation of highfrequency return series.*

Description

Function returns the rTPVar, defined in Andersen et al. (2012).

Assume there is N equispaced returns in period t. Let $r_{t,i}$ be a return (with $i = 1, \ldots, N$) in period t.

Then, the rTPVar is given by

$$\mathrm{rTPVar}_t = \frac{N}{N-2}\frac{\Gamma^2\left(1/2\right)}{4\Gamma^2\left(7/6\right)}\sum_{i=3}^{N}(|r_{t,i}|^{4/3}|r_{t,i-1}|^{4/3}|r_{t,i-2}|^{4/3})$$

Usage

```
rTPVar (rdata, align.by=NULL, align.period=NULL, makeReturns=FALSE,...)
```

Arguments

rdata	a zoo/xts object containing all returns in period t for one asset.
align.by	a string, align the tick data to "seconds"|"minutes"|"hours"
align.period	an integer, align the tick data to this many [seconds|minutes|hours].
makeReturns	boolean, should be TRUE when rdata contains prices instead of returns. FALSE by default.
...	additional arguments.

Value

numeric

Author(s)

Giang Nguyen, Jonathan Cornelissen and Kris Boudt

References

Andersen, T. G., D. Dobrev, and E. Schaumburg (2012). Jump-robust volatility estimation using nearest neighbor truncation. Journal of Econometrics, 169(1), 75- 93.

Examples

```
data(sample_tdata)
rTPVar(rdata= sample_tdata$PRICE, align.by= "minutes", align.period =5, makeReturns= TRUE)
rTPVar
```

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