# Package 'COINT'

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**Type** Package

**Title** Unit Root Tests with Structural Breaks and Fully-Modified Estimators

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**Description** Procedures include Phillips (1995) FMVAR <doi:10.2307/2171721>, Kitamura and Phillips (1997) FMGMM <doi:10.1016/S0304-4076(97)00004-3>, and Park (1992) CCR <doi:10.2307/2951679>, and so on. Tests with 1 or 2 structural breaks include Gregory and Hansen (1996) <doi:10.1016/0304-4076(69)41685-7>, Zivot and Andrews (1992) <doi:10.2307/1391541>, and Kurozumi (2002) <doi:10.1016/S0304-4076(01)00106-3>.

**Encoding** UTF-8

**License** GPL (>= 2)

**LazyData** TRUE

**LazyLoad** yes

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**NeedsCompilation** no

**Repository** CRAN

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# Contents

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bartlett                                   *Bartlett Kernel for Consistent Estimate of Long-run Variance*

---

## Description

Compute the Bartlett kernel to obtain consistent estimate of long-run variance of multivariate time series.

## Usage

```
bartlett(data,v)
```

## Arguments

| | |
|---|---|
| data | Data matrix for computing consistent long-run variance, normally, multivariate regression residuals. |
| v | Number of autocovariance terms in the kernel. |

## Value

Return the consistent estimate of long-run variance. This procedure handles both multivariate and single time series, which is basically designed for "fmvar","fmgmm" and "fmols".

## Author(s)

Ho Tsung-wu <tsungwu@ntnu.edu.tw>, College of Management, National Taiwan Normal University.

## References

Brillinger, David R. (1981) Time Series Data Analysis and Theory. San Francisco, CA: Holden-Day.

## Examples

```
data(macro)
e=apply(macro, 2, function(x) x-mean(x))
bartlett(e,v=15)
```

---

| Bartlett_uni | *Bartlett Kernel for Consistent Estimate of Long-run Variance* |
|---|---|

---

## Description

Compute the Bartlett kernel to obtain consistent estimate of long-run variance,univariate time series only.

## Usage

```
Bartlett_uni(e,v)
```

## Arguments

| | |
|---|---|
| e | A univariate time series for computing consistent long-run variance, normally, regression residuals. |
| v | Number of lag terms used to compute the long-run variance. |

**Value**

Return the consistent estimate of long-run variance, that PP and KPSS tests require. This procedure handles single time series only.

**Author(s)**

Ho Tsung-wu <tsungwu@ntnu.edu.tw>, College of Management, National Taiwan Normal University.

**References**

Brillinger, David R. (1981) Time Series Data Analysis and Theory. San Francisco, CA: Holden-Day.

**Examples**

```
data(macro)
y=macro[,"INF"]
e=y-mean(y)
Bartlett_uni(e,v=15)
```

---

bohman                            *Bohman Kernel for Consistent Estimate of Long-run Variance*

---

**Description**

Computes the Bohman window to obtain consistent estimate of long-run variance of multivariate time series.

**Usage**

```
bohman(data,v)
```

**Arguments**

| | |
|---|---|
| data | Data matrix for computing consistent long-run variance, normally, multivariate regression residuals. |
| v | Number of autocovariance terms in the kernel. |

**Value**

Return the consistent estimate of long-run variance. This procedure handles both multivariate and single time series, which is basically designed for "fmvar","fmgmm" and "fmols".

**Author(s)**

Ho Tsung-wu <tsungwu@ntnu.edu.tw>, College of Management, National Taiwan Normal University.

### References

Brillinger, David R. (1981) Time Series Data Analysis and Theory. San Francisco, CA: Holden-Day.

### Examples

```
data(macro)
e=apply(macro, 2, function(x) x-mean(x))
bohman(e,v=15)
```

---

| cauchy | *Cauchy Kernel for Consistent Estimate of Long-run Variance* |
|---|---|

---

### Description

Compute the Cauchy window to obtain consistent estimate of long-run variance of multivariate time series.

### Usage

```
cauchy(data,v)
```

### Arguments

| | |
|---|---|
| data | Data matrix for computing consistent long-run variance, normally, multivariate regression residuals. |
| v | Number of autocovariance terms in the kernel. |

### Value

Return the consistent estimate of long-run variance. This procedure handles both multivariate and single time series, which is basically designed for "fmvar","fmgmm" and "fmols".

### Author(s)

Ho Tsung-wu

### References

Brillinger, David R. (1981) Time Series Data Analysis and Theory. San Francisco, CA: Holden-Day.

### Examples

```
data(macro)
e=apply(macro, 2, function(x) x-mean(x))
cauchy(e,v=15)
```

---

ccr                                *Canonical Cointegrating Regression Estimator*

---

## Description

Computes Park's (1992) Canonical Cointegrating Regression estimator for cointegrated regression models, using OLS for the first stage regression.

## Usage

```
ccr(y,x,type=c("const","trend","season","all"),
    v=15,ker_fun="parzen",aband=0,filter=0)
```

## Arguments

| | |
|---|---|
| y | The data of dependent variable in a regression. |
| x | The data of independent variables in a regression. |
| type | The deterministic parts in the regression.<br>const = intercept;<br>trend = lnear trend;<br>season = seasonal dummies, this option requires ts format;<br>all = all three options, which requires ts format. |
| v | Number of autocovariance terms to compute the spectrum at frequency zero, default=15. |
| ker_fun | Set kernel function to one of the available kernels, default="parzen". See section details below. |
| aband | Whether to activate the automatic bandwidth selection.<br>aband=1. To activate.<br>aband=0. Do not activate.The default. |
| filter | Whether to use an AR(1) filter to compute the spectrum at frequency zero.<br>filter=1. To use.<br>filter=0. Do not use.The default. |

## Details

1. Available kernels. Technical details are referred to Brillinger (1981,P.55)
"parzen"=Parzen kernel
"bartlett"=Bartlett kernel
"dchlet"= Dirichlet kernel
"mdchlet"= Modified Dirichlet kernel
"tukham"=Tukey-Hamming kernel
"tukhan"=Tukey-Hanning kernel
"cauchy"=Cauchy kernel
"bohman"=Bohman kernel
"reisz"=Riesz,Bochner kernel

"gw"= Gauss-Weierstrass kernel
"qs"= Andrews (1991) Quadratic-Spectral

These kernels are written for ccr procedures, technically different from those used in pp and kpss tests.

2. Andrews (1991) has developed data based (or automatic) bandwidth procedures for computing the spectrum. COINT implements these procedures for the Parzen, Bartlette, Tukey-Hamming, and the Quadratic-Spectral kernels. When aband is active, COINT ignores the value you specify for the band-width parameter and automatically substitutes the data-based value.

3. The aim of the AR(1) filter is to flatten the spectrum of residual around the zero frequency, thereby making it easier to estimate the true spectrum by simple averaging of the periodogram.

## Value

| | |
|---|---|
| coefTable | Coefficients table. |
| vcov | Variance-covariance matrix for the parameter estimates. |
| sigma | Standard error of the residuals. |
| rss | Residual sum of squares. |
| fit | The fitted values, or conditional mean, of the regression. |
| resid | Estimated residuals. |

## Author(s)

Ho Tsung-wu <tsungwu@ntnu.edu.tw>, College of Management, National Taiwan Normal University.

## References

Park, J. Y. (1992) Canonical Cointegrating Regressions. *Econometrica*, 60, 119-144.

## Examples

```
data(macro)
y=macro[,1]
x=macro[,-1]
out=ccr(y,x,type=c("const","trend","season","all")[2],v=15,ker_fun="bartlett")
out$coefTable
out$vcov
tail(out$fit)
tail(out$resid)
```

---

ccrQ                                    *Canonical Cointegrating Regression with Time Polynomial*

---

### Description

Computes Park's (1992) canonical cointegrating regression estimator for cointegrated regressions with time polynomial, using OLS for the first stage regression.

### Usage

```
ccrQ(y,
     x,
     type=c("trend","all"),
     v=15,
     q=2,
     ker_fun="parzen",
     aband=0,
     filter=0)
```

### Arguments

| | |
|---|---|
| y | The data of dependent variable in a regression. |
| x | The data of independent variables in a regression. |
| type | The deterministic parts in the regression.<br>const = intercept;<br>trend = lnear trend;<br>season = seasonal dummies, this option requires `ts` format;<br>all = all three options, which requires `ts` format. |
| v | Number of autocovariance terms to compute the spectrum at frequency zero, default=15. |
| q | degree of time polynomial, default=2. |
| ker_fun | Set kernel function to one of the available kernels, default="parzen". See section `details` below. |
| aband | Whether to activate the automatic bandwidth selection.<br>aband=1. To activate.<br>aband=0. Do not activate.The default. |
| filter | Whether to use an AR(1) filter to compute the spectrum at frequency zero.<br>filter=1. To use.<br>filter=0. Do not use.The default. |

### Details

1. Available kernels. Technical details are referred to Brillinger (1981,P.55)
"parzen"=Parzen kernel
"bartlett"=Bartlett kernel

"dchlet"= Dirichlet kernel
"mdchlet"= Modified Dirichlet kernel
"tukham"=Tukey-Hamming kernel
"tukhan"=Tukey-Hanning kernel
"cauchy"=Cauchy kernel
"bohman"=Bohman kernel
"reisz"=Riesz,Bochner kernel
"gw"= Gauss-Weierstrass kernel
"qs"= Andrews (1991) Quadratic-Spectral

These kernels are written for ccrQ procedures, technically different from those used in pp and kpss tests.

2. Andrews (1991) has developed data based (or automatic) bandwidth procedures for computing the spectrum. COINT implements these procedures for the Parzen, Bartlette, Tukey-Hamming, and the Quadratic-Spectral kernels. When aband is active, COINT ignores the value you specify for the band-width parameter and automatically substitutes the data-based value.

3. The aim of the AR(1) filter is to flatten the spectrum of residual around the zero frequency, thereby making it easier to estimate the true spectrum by simple averaging of the periodogram.

### Value

| | |
|---|---|
| coefTable | Coefficients table. |
| vcov | Variance-covariance matrix for the parameter estimates. |
| sigma | Standard error of the residuals. |
| rss | Residual sum of squares. |
| fit | The fitted values, or conditional mean, of the regression. |
| resid | Estimated residuals. |

### Author(s)

Ho Tsung-wu <tsungwu@ntnu.edu.tw>, College of Management, National Taiwan Normal University.

### References

Park, J. Y. (1992) Canonical Cointegrating Regressions. *Econometrica*, 60, 119-144.

### Examples

```
data(macro)
y=macro[,1]
x=macro[,-1]
out=ccrQ(y,x,q=3,type=c("trend","all")[1],v=15,ker_fun="parzen")
out$coefTable
out$vcov
tail(out$fit)
tail(out$resid)
```

---

CZa                    *Phillips' (1987) Za and Zt test for cointegration*

---

### Description

Test the null hypothesis of no cointegration between y and x using Phillips' (1987) Za and Zt statistics and Phillips and Ouliaris (1990) limit theory.

### Usage

```
CZa(y,x,p=1,v=15)
```

### Arguments

| | |
|---|---|
| y | The data of dependent variable in a regression. |
| x | The data of independent variables in a regression. |
| p | Order of the time polynomial in the cointegrating regressio. Critical values are available for p within [1,5].<br>p =-1: No deterministic term in the cointegrating regression.<br>p = 0: For a constant term.<br>p = 1: For a constant term and trend. Default.<br>P > 2: For time polynomial. |
| v | Number of autocovariance terms to compute the spectrum at frequency zero, default=15. |

### Value

| | |
|---|---|
| alpha | Estimate of the AR(1) coefficient. |
| cza | Za statistic for non-cointegration.Reject the null hypothesis of no cointegration if the Z statistic < critical value. |
| cza_cv | Critical values of cza. |
| czt | Zt statistic for non-cointegration.Reject the null hypothesis of no cointegration if the Z statistic < critical value. |
| czt_cv | Critical values of czt. |

### Author(s)

Ho Tsung-wu <tsungwu@ntnu.edu.tw>, College of Management, National Taiwan Normal University.

### References

Phillips, P. C. B. (1987) Time Series Regression with a Unit Root. *Econometrica*, 55, 277-301.
Phillips, P. C. B. and Ouliaris S. (1990) Asymptotic Properties of Residual Based Tests for Cointegration. *Econometrica*, 58, 165-193.

## Examples

```
data(macro)
y=macro[,1]
x=macro[,-1]
CZa(y,x,p=1,v=10)
```

---

data-sets                    *Macroeconomic Time Series Data Sets, 1967M1-2025M7*

---

## Description

macro contains monthly observations from 1967M1 to 2025M7 for the unemployment rate (the dependent variable), IC (Initial Claims of unemployment insurance), inflation rate (seasonal growth rate of CPI), industrial growth (seasonal growth rate of the industrial production index).r

## Usage

```
data(macro)
```

## Value

macro is an object of class timeSeries.

---

dchlet                    *Dirichlet Kernel for Consistent Estimate of Long-run Variance*

---

## Description

Computes the Dirichlet window to obtain consistent estimate of long-run variance of multivariate time series.

## Usage

```
dchlet(data,v)
```

## Arguments

data          Data matrix for computing consistent long-run variance, normally, multivariate regression residuals.

v             Number of autocovariance terms in the kernel.

## Value

Return the consistent estimate of long-run variance. This procedure handles both multivariate and single time series, which is basically designed for "fmvar","fmgmm" and "fmols".

**Author(s)**

Ho Tsung-wu <tsungwu@ntnu.edu.tw>, College of Management, National Taiwan Normal University.

**References**

Brillinger, David R. (1981) Time Series Data Analysis and Theory. San Francisco, CA: Holden-Day.

**Examples**

```
data(macro)
e=apply(macro, 2, function(x) x-mean(x))
dchlet(e,v=15)
```

---

fm                               *Fully-Modified OLS Estimator*

---

**Description**

Computes the Phillips-Hansen (1990) Fully-Modified estimator for cointegrated regressions, using OLS for the first stage regression.

**Usage**

```
fm(y,
    x,
    type=c("const","trend","season","all"),
    v=15,
    ker_fun="parzen",
    aband=0,
    filter=0,
    sb_start=0.15)
```

**Arguments**

| | |
|---|---|
| y | The data of dependent variable in a regression. |
| x | The data of independent variables in a regression. |
| type | The deterministic parts in the regression.<br>const = intercept;<br>trend = lnear trend;<br>season = seasonal dummies, this option requires ts format;<br>all = all three options, which requires ts format. |
| v | Number of autocovariance terms to compute the spectrum at frequency zero, default=15. |

| | |
|---|---|
| ker_fun | Set kernel function to one of the available kernels, default="parzen". See section `details` below. |
| aband | Whether to use the automatic bandwidth selection.<br>aband=1. To use.<br>aband=0. Do not use.The default. |
| filter | Whether to activate an AR(1) filter to compute the spectrum at frequency zero.<br>filter=1. To activate.<br>filter=0. Do not activate.The default. |
| sb_start | The percentage specifies the beginning of sub-sample for stability test, and the end sample is *(1-sb_start)*. |

## Details

1. Available kernels. Technical details are referred to Brillinger (1981,P.55)
"parzen"=Parzen kernel
"bartlett"=Bartlett kernel
"dchlet"= Dirichlet kernel
"mdchlet"= Modified Dirichlet kernel
"tukham"=Tukey-Hamming kernel
"tukhan"=Tukey-Hanning kernel
"cauchy"=Cauchy kernel
"bohman"=Bohman kernel
"reisz"=Riesz,Bochner kernel
"gw"= Gauss-Weierstrass kernel
"qs"= Andrews (1991) Quadratic-Spectral

These kernels are written for FM procedures, technically different from those used in pp and kpss tests.

2. Andrews (1991) has developed data based (or automatic) bandwidth procedures for computing the spectrum. COINT implements these procedures for the Parzen, Bartlette, Tukey-Hamming, and the Quadratic-Spectral kernels. When aband is active, COINT ignores the value you specify for the band-width parameter and automatically substitutes the data-based value.

3. The aim of the AR(1) filter is to flatten the spectrum of residual around the zero frequency, thereby making it easier to estimate the true spectrum by simple averaging of the periodogram.

## Value

| | |
|---|---|
| coefTable | Coefficients table. |
| vcov | Variance-covariance matrix for the parameter estimates. |
| sigma | Standard error of the residuals. |
| rss | Residual sum of squares. |
| fit | The fitted values, or conditional mean, of the regression. |
| stests | 3x1 vector containing Hansen's (1992) Lc, MeanF, and SupF (in this order) statistics for testing the null hypothesis that the cointegrating vector is stable over the sample period. |
| resid | Estimated residuals. |

## Author(s)

Ho Tsung-wu <tsungwu@ntnu.edu.tw>, College of Management, National Taiwan Normal University.

## References

Andrews, D. W. K. (1991) Heteroskedasticity and Autocorrelation Consistent Covariance Matrix Estimation.*Econometrica*, 59: 817-858.

Brillinger, David R. (1981) *Time Series Data Analysis and Theory*. San Francisco, CA: Holden-Day.

Hansen, B. E. (1992) Tests for Parameter Instability in Regressions with I(1) Processes. *Journal of Business and Economic Statistics*, 10, 321-335.

Phillips, P. C. B. and Hansen B. E.(1990) Statistical Inference in Instrumental Variables Regression with I(1) Processes. *Review of Economic Studies*, 57, 99-125.

## Examples

```
data(macro)
y=macro[,1]
x=macro[,-1]
out=fm(y,x,type=c("const","trend","season","all")[2],v=15,ker_fun="parzen")
out$coefTable
out$vcov
out$stests
tail(out$fit)
tail(out$resid)
```

---

fmgmm                          *Fully-Modified GMM Estimator*

---

## Description

Computes the Kitamura-Phillips (1997) Fully-Modified GMM estimator for single equation and multivariate cointegrated regression models.

## Usage

```
fmgmm(y,x,z,v,ker_fun="parzen",aband=0,times=5)
```

## Arguments

| | |
|---|---|
| y | The data of dependent variable(s) in a regression. |
| x | The data of independent variables in a regression. |
| z | Instruments |
| v | Number of autocovariance terms to compute the spectrum at frequency zero, default=15. |
| ker_fun | Set kernel function to one of the available kernels, default="parzen". See section details below. |
| aband | Whether to activate the automatic bandwidth selection. <br> aband=1. To activate. <br> aband=0. Do not activate.The default. |
| times | Number of iteration to compute GMM residuals, default =5. |

## Details

1. Like FMOLS, fmgmm allows both single equation and multivariate system of equations. The multvariate case is a system that many dependent variables to common Xs.

2. Available kernels. Technical details are referred to Brillinger (1981,P.55)

"parzen"=Parzen kernel
"bartlett"=Bartlett kernel
"dchlet"= Dirichlet kernel
"mdchlet"= Modified Dirichlet kernel
"tukham"=Tukey-Hamming kernel
"tukhan"=Tukey-Hanning kernel
"cauchy"=Cauchy kernel
"bohman"=Bohman kernel
"reisz"=Riesz,Bochner kernel
"gw"= Gauss-Weierstrass kernel
"qs"= Andrews (1991) Quadratic-Spectral

These kernels are written for FM procedures, technically different from those used in pp and kpss tests.

3. Andrews (1991) has developed data based (or automatic) bandwidth procedures for computing the spectrum. COINT implements these procedures for the Parzen, Bartlette, Tukey-Hamming, and the Quadratic-Spectral kernels. When aband is active, COINT ignores the value you specify for the band-width parameter and automatically substitutes the data-based value.

4. The aim of the AR(1) filter is to flatten the spectrum of residual around the zero frequency, thereby making it easier to estimate the true spectrum by simple averaging of the periodogram.

## Value

| | |
|---|---|
| beta | Coefficient estimates. |
| stderr | Standard error of the residuals. |

| | |
|---|---|
| tstat | t-statistics of parameter estimates. |
| vcov | Variance-covariance matrix for the parameter estimates. |
| lromega | long-run variance-covariance matrix of residuals. |
| s1 | The first statistic for testing validity of overidentifying restrictions. |
| s2 | The second statistic for testing validity of overidentifying restrictions. |
| pvalue | The p-value for s1+s2. |
| fit | The fitted values, or conditional mean, of the regression. |
| resid | GMM residuals. |

## Author(s)

Ho Tsung-wu <tsungwu@ntnu.edu.tw>, College of Management, National Taiwan Normal University.

## References

Kitamura, Y. and P. C. B. Phillips (1997) Fully-Modified IV, GIVE and GMM Estimation with Possibly Nonstationary Regressors and Instruments. *Journal of Econometrics*, 80, 85-123.

## Examples

```
data(macro)

y=macro[-1,c(1,4)]
x=macro[-1,c(2,3)]
z=as.matrix(na.omit(diff(macro))) #IV

out=fmgmm(y,x,z,v=15,ker_fun="parzen")
out$beta
out$vcov
out$stderr
out$tstat #t-ratio
tail(out$fit)
tail(out$resid)
```

---

fmols                              *Multivariate Fully-Modified OLS Estimator*

---

## Description

Phillips' (1995) Fully-Modified OLS estimator for single equation and multivariate cointegrated regression models.

## Usage

```
fmols(y,
      x,
      type=c("const","trend","season","all"),
      v=15,
      ker_fun="parzen",
      aband=0,
      filter=1)
```

## Arguments

| | |
|---|---|
| y | The data of dependent variable(s) in a regression. |
| x | The data of independent variables in a regression. |
| type | The deterministic parts in the regression. <br> const = intercept; <br> trend = lnear trend; <br> season = seasonal dummies, this option requires `ts` format; <br> all = all three options, which requires `ts` format. |
| v | Number of autocovariance terms to compute the spectrum at frequency zero, default=15. |
| ker_fun | Set kernel function to one of the available kernels, default="parzen". See section `details` below. |
| aband | Whether to activate the automatic bandwidth selection. <br> aband=1. To activate. <br> aband=0. Do not activate.The default. |
| filter | Whether to use an AR(1) filter to compute the spectrum at frequency zero. <br> filter=1. To use.The default. <br> filter=0. Do not use. |

## Details

1. This fmols allows both single equation and multivariate system of equations. The multvariate case is a system that many dependent variables to common Xs. 2. Available kernels. Technical details are referred to Brillinger (1981,P.55)

"parzen"=Parzen kernel
"bartlett"=Bartlett kernel
"dchlet"= Dirichlet kernel
"mdchlet"= Modified Dirichlet kernel
"tukham"=Tukey-Hamming kernel
"tukhan"=Tukey-Hanning kernel
"cauchy"=Cauchy kernel
"bohman"=Bohman kernel
"reisz"=Riesz,Bochner kernel
"gw"= Gauss-Weierstrass kernel
"qs"= Andrews (1991) Quadratic-Spectral

These kernels are written for fmols procedures, technically different from those used in pp and kpss tests.

3. Andrews (1991) has developed data based (or automatic) bandwidth procedures for computing the spectrum. COINT implements these procedures for the Parzen, Bartlette, Tukey-Hamming, and the Quadratic-Spectral kernels. When aband is active, COINT ignores the value you specify for the band-width parameter and automatically substitutes the data-based value.

4. The aim of the AR(1) filter is to flatten the spectrum of residual around the zero frequency, thereby making it easier to estimate the true spectrum by simple averaging of the periodogram.

### Value

| | |
|---|---|
| beta | Coefficient estimates. |
| stderr | Standard error of the residuals. |
| tstat | t-statistics of parameter estimates. |
| vcov | Variance-covariance matrix for the parameter estimates. |
| fit | The fitted values, or conditional mean, of the regression. |
| resid | Estimated residuals. |

### Author(s)

Ho Tsung-wu <tsungwu@ntnu.edu.tw>, College of Management, National Taiwan Normal University.

### References

Phillips, P. C. B (1995) Fully Modified Least Squares and Vector Autoregression, *Econometrica*, 63, 1023-1078.

### Examples

```
data(macro)
y=macro[,1:2]
x=macro[,3:4]
out=fmols(y,x,type=c("const","trend","season","all")[2],v=15,ker_fun="bartlett")
out$beta
out$stderr
out$tstat #t-ratio
out$vcov
tail(out$fit)
tail(out$resid)
```

fmQ                          *Fully-Modified OLS Estimator with Time Polynomial*

### Description

Computes the Phillips-Hansen (1990) Fully-Modified estimator for cointegrated regressions with Time Polynomial, using OLS for the first stage regression.

### Usage

```
fmQ(y,x,type=c("trend","all"),v=15,
    q=2, ker_fun="parzen",aband=0,filter=0,sb_start=0.15)
```

### Arguments

| | |
|---|---|
| y | The data of dependent variable in a regression. |
| x | The data of independent variables in a regression. |
| type | The deterministic parts in the regression.<br>trend = lnear trend;<br>all = all three options, which requires ts format. |
| v | Number of autocovariance terms to compute the spectrum at frequency zero, default=15. |
| q | degree of time polynomial, default=2. |
| ker_fun | Set kernel function to one of the available kernels, default="parzen". See section details below. |
| aband | Whether to activate the automatic bandwidth selection.<br>aband=1. To activate.<br>aband=0. Do not activate.The default. |
| filter | Whether to use an AR(1) filter to compute the spectrum at frequency zero.<br>filter=1. To use.<br>filter=0. Do not use. The default. |
| sb_start | The percentage specifies the beginning of sub-sample for stability test, and the end sample is *(1-sb_start)*. |

### Details

1. Available kernels. Technical details are referred to Brillinger (1981,P.55)
"parzen"=Parzen kernel
"bartlett"=Bartlett kernel
"dchlet"= Dirichlet kernel
"mdchlet"= Modified Dirichlet kernel
"tukham"=Tukey-Hamming kernel
"tukhan"=Tukey-Hanning kernel
"cauchy"=Cauchy kernel
"bohman"=Bohman kernel

"reisz"=Riesz,Bochner kernel
"gw"= Gauss-Weierstrass kernel
"qs"= Andrews (1991) Quadratic-Spectral

These kernels are written for fmQ procedures, technically different from those used in `pp` and `kpss` tests.

2. Andrews (1991) has developed data based (or automatic) bandwidth procedures for computing the spectrum. `COINT` implements these procedures for the Parzen, Bartlette, Tukey-Hamming, and the Quadratic-Spectral kernels. When aband is active, COINT ignores the value you specify for the band-width parameter and automatically substitutes the data-based value.

3. The aim of the AR(1) filter is to flatten the spectrum of residual around the zero frequency, thereby making it easier to estimate the true spectrum by simple averaging of the periodogram.

## Value

| | |
|---|---|
| coefTable | Coefficients table. |
| vcov | Variance-covariance matrix for the parameter estimates. |
| sigma | Standard error of the residuals. |
| rss | Residual sum of squares. |
| fit | The fitted values, or conditional mean, of the regression. |
| resid | Estimated residuals. |

## Author(s)

Ho Tsung-wu <tsungwu@ntnu.edu.tw>, College of Management, National Taiwan Normal University.

## References

Andrews, D. W. K. (1991) Heteroskedasticity and Autocorrelation Consistent Covariance Matrix Estimation.*Econometrica*, 59: 817-858.
Brillinger, David R. (1981) *Time Series Data Analysis and Theory*. San Francisco, CA: Holden-Day.
Hansen, B. E. (1992) Tests for Parameter Instability in Regressions with I(1) Processes. *Journal of Business and Economic Statistics*, 10, 321-335.
Phillips, P. C. B. and Hansen B. E.(1990) Statistical Inference in Instrumental Variables Regression with I(1) Processes. *Review of Economic Studies*, 57, 99-125.

## Examples

```
data(macro)
y=macro[,1]
x=macro[,-1]
out=fmQ(y,x,type=c("trend","all")[1],v=15,q=3,ker_fun="parzen")
out$coefTable
out$vcov
```

```
out$stests
tail(out$fit)
tail(out$resid)
```

## fmvar                              *Fully-Modified VAR Estimator*

### Description

Computes the Phillips' (1995) Fully-Modified" VAR estimator for cointegrated regressions, using OLS for the first stage regression.

### Usage

```
fmvar(data,p=1,q=5,v=15,type=c("const","trend","season","all"),
                 ker_fun="parzen",aband=0,filter=0)
```

### Arguments

| | |
|---|---|
| data | The dependent variables for a VAR system. |
| p | The number of lags for dependent variables, as in a VAR(p). |
| q | The number of lagged innovation terms to include in the fitted FMVAR(p,q). |
| v | Number of autocovariance terms to compute the spectrum at frequency zero, default=15. |
| type | The deterministic parts in the regression. Please note that fmvar will "de-" before inclusion, for example, trend is to pre-detrend the data.<br>const = intercept;<br>trend = lnear trend;<br>season = seasonal dummies, this option requires ts format;<br>all = all three options, which requires ts format. |
| ker_fun | Set kernel function to one of the available kernels, default="parzen". See section details below. |
| aband | Whether to activate the automatic bandwidth selection.<br>aband=1. To activate.<br>aband=0. Do not activate.The default. |
| filter | Whether to use an AR(1) filter to compute the spectrum at frequency zero.<br>filter=1. To use.<br>filter=0. Do not use. The default. |

**Details**

1. Available kernels. Technical details are referred to Brillinger (1981,P.55)
"parzen"=Parzen kernel
"bartlett"=Bartlett kernel
"dchlet"= Dirichlet kernel
"mdchlet"= Modified Dirichlet kernel
"tukham"=Tukey-Hamming kernel
"tukhan"=Tukey-Hanning kernel
"cauchy"=Cauchy kernel
"bohman"=Bohman kernel
"reisz"=Riesz,Bochner kernel
"gw"= Gauss-Weierstrass kernel
"qs"= Andrews (1991) Quadratic-Spectral

These kernels are written for FM procedures, technically different from those used in pp and kpss
tests.

2. Andrews (1991) has developed data based (or automatic) bandwidth procedures for computing
the spectrum. COINT implements these procedures for the Parzen, Bartlette, Tukey-Hamming, and
the Quadratic-Spectral kernels. When aband is active, COINT ignores the value you specify for the
band-width parameter and automatically substitutes the data-based value.
3. The aim of the AR(1) filter is to flatten the spectrum of residual around the zero frequency,
thereby making it easier to estimate the true spectrum by simple averaging of the periodogram.

**Value**

| | |
|---|---|
| beta | Coefficient estimates. |
| stderr | Standard error of the residuals. |
| tstat | t-statistics of parameter estimates. |
| vcov | Variance-covariance matrix for the parameter estimates. |
| fit | The fitted values, or conditional mean, of the regression. |
| resid | Estimated residuals. |
| data | The data used in fmvar |
| type | The type used in fmvar |
| p | The p argument used in fmvar |
| q | The q argument used in fmvar |

**Author(s)**

Ho Tsung-wu <tsungwu@ntnu.edu.tw>, College of Management, National Taiwan Normal University.

**References**

Phillips, P. C. B (1995) Fully Modified Least Squares and Vector Autoregression. *Econometrica*,
63, 1023-1078.

## Examples

```
data(macro)
out=fmvar(macro,p=1,q=6,v=15,type="trend",ker_fun="parzen",aband=0,filter=0)
out$beta
out$stderr
out$tstat
out$vcov
tail(out$data)
tail(out$resid)

ID1=grep(rownames(out$beta),pattern="_dL")
ID2=grep(rownames(out$beta),pattern="_L")
ID3=rownames(out$beta)[-c(ID1,ID2)]

out$beta[ID1,]; #innovation terms
out$beta[ID2,]; #VAR(1)
out$beta[ID3,]; #deterministic parts
```

---

| fmvar_forecast | *Forecast a FM-VAR System* |
|---|---|

---

## Description

Forecast a VAR generated by fmvar_forecast.

## Usage

```
fmvar_forecast(output, n.ahead=6)
```

## Arguments

output       The output object of fmvar_forecast.

n.ahead      The steps of out-of-sample forecasting.

## Details

This function recursively computes the n.ahead steps of out-of-sample forecasting.

## Value

Forecasted values of all endogenous variables.

## Author(s)

Ho Tsung-wu <tsungwu@ntnu.edu.tw>, College of Management, National Taiwan Normal University.

## Examples

```
data(macro)
out=fmvar(macro,p=1,q=6,v=10,type="trend",ker_fun="parzen")
fmvar_forecast(out,n.ahead=6)
```

---

fmvar_plag                          *Select the q in a FMVAR(p,q) by Specific Criterion*

---

## Description

Select the q for a FMVAR(p,q) for cointegrated regressions.

## Usage

```
fmvar_plag(data,
           p=1,
           lag.max=12,
           v=15,
           type=c("const","trend","season","all"),
           ker_fun="parzen",
           aband=0,
           filter=0)
```

## Arguments

| | |
|---|---|
| data | The dependent variables for a VAR system. |
| p | The number of lags for dependent variables, as in a standard VAR(p). |
| lag.max | The maxum number of lags used to search for optimal q in fmvar(p,q). |
| v | Number of autocovariance terms to compute the spectrum at frequency zero, default=15. |
| type | The deterministic parts in the regression.<br>const = intercept;<br>trend = lnear trend;<br>season = seasonal dummies, this option requires ts format;<br>all = all three options, which requires ts format. |
| ker_fun | Set kernel function to one of the available kernels, default="parzen". See section details below. |
| aband | Whether to activate the automatic bandwidth selection.<br>aband=1. To activate.<br>aband=0. Do not activate.The default. |
| filter | Whether to use an AR(1) filter to compute the spectrum at frequency zero.<br>filter=1. To use.<br>filter=0. Do not use. The default. |

### Details

1. Available kernels. Technical details are referred to Brillinger (1981,P.55)
"parzen"=Parzen kernel
"bartlett"=Bartlett kernel
"dchlet"= Dirichlet kernel
"mdchlet"= Modified Dirichlet kernel
"tukham"=Tukey-Hamming kernel
"tukhan"=Tukey-Hanning kernel
"cauchy"=Cauchy kernel
"bohman"=Bohman kernel
"reisz"=Riesz,Bochner kernel
"gw"= Gauss-Weierstrass kernel
"qs"= Andrews (1991) Quadratic-Spectral

These kernels are written for fm.ols procedures, technically different from those used in pp and kpss tests.

2. Andrews (1991) has developed data based (or automatic) bandwidth procedures for computing the spectrum. COINT implements these procedures for the Parzen, Bartlette, Tukey-Hamming, and the Quadratic-Spectral kernels. When aband is active, COINT ignores the value you specify for the band-width parameter and automatically substitutes the data-based value.
3. The aim of the AR(1) filter is to flatten the spectrum of residual around the zero frequency, thereby making it easier to estimate the true spectrum by simple averaging of the periodogram.

### Value

| | |
|---|---|
| selection | The selected order of q: the selected lagged innovation terms to include in the fitted FMVAR(p,q) |
| criteria | The matrix of all lags and the values of four criteria: "AIC(q)", "HQ(q)", "SC(q)", "FPE(q)". |

### Author(s)

Ho Tsung-wu <tsungwu@ntnu.edu.tw>, College of Management, National Taiwan Normal University.

### References

Phillips, P. C. B (1995) Fully Modified Least Squares and Vector Autoregression. *Econometrica*, 63, 1023-1078.

### Examples

```
data(macro)

Q=fmvar_plag(macro,
          p=1,
```

```
            v=15,
            lag.max=16,type="trend",
            ker_fun="parzen")$selection[1]

out=fmvar(macro,p=1,q=Q,v=15,type="trend", ker_fun="parzen")
```

---

GHansen                    *Gregory-Hansen Test for Cointegration in Models with Regime Shifts*

---

## Description

Conduct the cointegration analysis with regime shifts, proposed by Gregory-Hansen (1996A).

## Usage

```
GHansen(y, x, model,trim=0.1, use=c("nw","ba"))
```

## Arguments

| | |
|---|---|
| y | The data of dependent variable in a regression. |
| x | The data of independent variables in a regression. |
| model | Models for the structural breaks:<br>1 = C (level shift);<br>2 = C/T (level shift with trend);<br>3 = C/S (regime shift);<br>4 = regime and trend shift. |
| trim | The trimming percentage. Default is 10 percent. |
| use | Conditions for pp test for the nonstationarity of regression residuals. |

## Details

This function calculates three residual-based test for cointegration with regime shifts: ADF, and Za, Zt of pp. Argument use is detailed by the example of pp documentation.

## Value

| | |
|---|---|
| result | Comprehensive results of three tests. |
| teststat | Time series of three sequential tests. |
| test.reg.adf | Final regression output for ADF test. |
| test.reg.za | Final regression output for Za test. |
| test.reg.zt | Final regression output for Zt test. |

## Author(s)

Ho Tsung-wu <tsungwu@ntnu.edu.tw>, College of Management, National Taiwan Normal University.

## References

Gregory, A.W. and Hansen, B. E. (1996A) Residual-based tests for cointegration in models with regime shifts.*Journal of Econometrics*, 70, 99-126.

Gregory, A.W. and Hansen, B. E.(1996B). Tests for Cointegration in Models with Regime and Trend Shifts. *Oxford Bulletin Economics and Statistics*, 58(3), 555-560.

## Examples

```
data(macro)
y=macro[1:300,1]
x=macro[1:300,-1]
output=GHansen(y,x,model=1, use=c("nw","ba"))
output$result
summary(output$test.reg.adf)
head(output$teststat)

#Plotting

test.name=rownames(output$result)[1]
stat=output$teststat[,test.name]
CV=output$result[test.name,1:3]
bpoint=output$result[test.name,5]
main=paste(paste(unlist(strsplit(test.name,"_")),collapse = " "),"test")

plot(stat,main=main,ylab="",xlab="",ylim=range(c(max(stat)+3,min(stat)-1,CV)));grid()
  abline(h=CV[1],col="red")
  abline(h=CV[2],col="blue")
  abline(h=CV[3],col="seagreen")
  abline(v=as.POSIXct(time(y)[bpoint]),col="orange",lty=2)

# legend(x=as.POSIXct("2010-01-01"), y=max(stat)+3, legend=c("1% cv" , "5% cv", "10% cv"),
#        col=c("red", "blue", "seagreen"),xjust=1, yjust=1, lty=1,
#        horiz=TRUE, cex=0.66, bty="n")



#plot(y,main=colnames(y),ylab="",xlab="");grid()
#abline(v=time(y[output$bpoint,]),col="orange",lty=2)
```

---

| gw | *Gauss-Weierstrass Kernel for Consistent Estimate of Long-run Variance* |
|---|---|

---

## Description

Computes the Gauss-Weierstrass window to obtain consistent estimate of long-run variance of multivariate time series.

## Usage

```
gw(data,v)
```

## Arguments

| | |
|---|---|
| data | Data matrix for computing consistent long-run variance, normally, multivariate regression residuals. |
| v | Number of autocovariance terms in the kernel. |

## Value

Return the consistent estimate of long-run variance. This procedure handles both multivariate and single time series, which is basically designed for "fmvar","fmgmm" and "fmols".

## Author(s)

Ho Tsung-wu <tsungwu@ntnu.edu.tw>, College of Management, National Taiwan Normal University.

## References

Brillinger, David R. (1981) *Time Series Data Analysis and Theory*. San Francisco, CA: Holden-Day.

## Examples

```
data(macro)
e=apply(macro, 2, function(x) x-mean(x))
gw(e,v=15)
```

---

| kpss | *KPSS Unit Root Test for the null of stationarity* |
|---|---|

---

## Description

Implement the KPSS unit root test for the null of I(0) stationarity. The test type as deterministic component is specified as x, see example below.

## Usage

```
kpss(y, x, lags = c("short", "long", "nil"), use=c("nw","ba"))
```

## Arguments

| | |
|---|---|
| y | Vector to be tested for a unit root. |
| x | data matrix for deterministic component. For example a vector of one for intercept, or trend. The default is "x=NULL", which is the same of a vector of one |
| lags | Lags used for correction of error term. |
| use | User specified lags for correction of error term. See section details below.The default is the lag determined by Newey-West bandwidth ("nw") with Bartlettkernel ("ba"). |

## Details

lags="short" sets the number of lags to $\sqrt[4]{4 \times (n/100)}$, whereas lags="long" sets the number of lags to $\sqrt[4]{12 \times (n/100)}$. If lags="nil" is choosen, no error correction is made.

Furthermore, "lags" and "use" are mutually exclusive: As long as "use" is not NULL, its argument will be chosen first. One can specify a different number of maximum lags by setting "use" accordingly. Users can input number of your souce. This version suports two bandwidth functions: "nw" for Newey-West and "and" for Andrews. The kernel functions are supported: "ba"=Bartlett, "pa"=Parzen, "qs"=Qudratic Spectral

## Value

| | |
|---|---|
| teststat | The KPSS test statistic. |
| cval | Critical values. |
| lag | Number of lags used for kernel function. |
| resid | Regression residuals. |

## Author(s)

Ho Tsung-wu <tsungwu@ntnu.edu.tw>, College of Management, National Taiwan Normal University.

## References

Kwiatkowski, D., Phillips, P.C.B., Schmidt, P. and Shin, Y. (1992) Testing the Null Hypothesis of Stationarity Against the Alternative of a Unit Root: How Sure Are We That Economic Time Series Have a Unit Root? *Journal of Econometrics*, 54,159-178.
Phillips, P.C.B. and Sainan Jin (2002) The KPSS test with seasonal dummies. *Economics Letters*, 77, 239-243.

## Examples

```
data(macro)
y=macro[,"INF"]
const=rep(1,nrow(y))
```

```
trend=seq(nrow(y))/nrow(y)
D=cbind(const,trend) #seasonal dummies can be specified here
KPSS=kpss(y,x=D,lags = c("short", "long", "nil")[2],
        use=c("nw","ba")) # If argument use isn't NULL, the argument "lags" will be ignored.
KPSS$teststat
KPSS$cval
KPSS$lag

kpss(y,x=D,lags = c("short", "long", "nil")[2],use=15)

kpss(y,x=D,
    lags = c("short", "long", "nil")[2],
    use=NULL) #if "use=NULL", argument "lags"  will be chosen as input.
```

---

kpss_1br                              *KPSS Unit Root Test with One Structural Break*

---

### Description

Implement the Kurozumi (2002) sequential kpss test with one structural break.

### Usage

```
kpss_1br(y,
        lags = c("short", "long", "nil"),
        model=c("intercept","both"),
        use=c("nw","ba"),
        trim=0.1)
```

### Arguments

| | |
|---|---|
| y | Vector to be tested for a unit root. |
| lags | Lags used for correction of error term. |
| model | Modelling where the unknown structural change occurs.<br>intercept= structural change occurs at the intercept.<br>both= structural changes occur at both the intercept and the trend. |
| use | User specified lags for correction of error term. The default is the lag determined by Newey-West bandwidth "nw" with Bartlett "ba" kernel. Users can input your own number. This version suports two bandwidth functions: "nw" for Newey-West, "and" for Andrews. Three kernel functions are supported by both bandwidth functions: "ba"=Bartlett, "pa"=Parzen, "qs"=Qudratic Spectral |
| trim | The trimming percentage. Default is 10 |

## Details

lags="short" sets the number of lags to $\sqrt[4]{4 \times (n/100)}$, whereas lags="long" sets the number of lags to $\sqrt[4]{12 \times (n/100)}$. If lags="nil" is choosen, then no error correction is made. Furthermore, lags and use are mutually exclusive. As long as use is not set to be NULL, its argumenta will be chosen fisrt. One can specify a different number of maximum lags by setting use accordingly.

## Value

teststat     The kpss test statistic with one structural break.

cval         Critical values.

bpoint       The breaking point that corresponds to the teststat.

tstats       The sequential KPSS test statistic.

## Author(s)

Ho Tsung-wu <tsungwu@ntnu.edu.tw>, College of Management, National Taiwan Normal University.

## References

Kwiatkowski, D., Phillips, P.C.B., Schmidt, P. and Shin, Y. (1992) Testing the Null Hypothesis of Stationarity Against the Alternative of a Unit Root: How Sure Are We That Economic Time Series Have a Unit Root? *Journal of Econometrics*, 54, 159-178.
Kurozumi, E. (2002) Testing for stationarity with a break. *Journal of Econometrics*,108(1), 105-127.
Phillips, P.C.B. and Sainan Jin (2002) The KPSS test with seasonal dummies. *Economics Letters*, 77, 239-243.

## Examples

```
data(macro)
y=macro[,"INF"]
KPSS1=kpss_1br(y,model=c("intercept","both")[2],use=c("nw","ba"))
KPSS1$teststat
KPSS1$cval
y[KPSS1$bpoint,]
#Plot
plot.ts(KPSS1$tstats,ylim=range(c(KPSS1$tstats,KPSS1$cval)));grid()
abline(h=KPSS1$cval[1],col="red")
abline(h=KPSS1$cval[2],col="blue")
abline(h=KPSS1$cval[3],col="green")
abline(v=KPSS1$bpoint,col="red",lty=2)
```

---

kpss_2br *KPSS Unit Root Test with Two Structural Breaks*

---

### Description

Implement the kpss unit root test with two unknown structural breaks. Carrion-i-Silvestre and Sanso (2007) extends Kurozumi (2002) to two breaks, and create critical values.

### Usage

```
kpss_2br(y, lags = c("short", "long", "nil"), model=1, use=c("nw","ba"),trace=TRUE)
```

### Arguments

| | |
|---|---|
| y | Vector to be tested for a unit root. |
| lags | Lags used for correction of error term. |
| model | Modelling where the unknown structural change occurs.<br>1 = AAn (Level shift without trend);<br>2 = AA (Level shift with trend);<br>3 = BB (Trend shift);<br>4 = CC (Level and trend shift)<br>Default is 1. |
| use | User specified lags for correction of error term. The default is the lag determined by Newey-West bandwidth "nw" with Bartlett "ba" kernel. Users can input your own number. This version suports two bandwidth functions: "nw" for Newey-West, "and" for Andrews. Three kernel functions are supported by both bandwidth functions: "ba"=Bartlett, "pa"=Parzen, "qs"=Qudratic Spectral |
| trace | Logical. If TURE (default), then screen displays the sequential progress. |

### Details

lags="short" sets the number of lags to $\sqrt[4]{4 \times (n/100)}$, whereas lags="long" sets the number of lags to $\sqrt[4]{12 \times (n/100)}$. If lags="nil" is choosen, then no error correction is made. Furthermore, lags and use are mutually exclusive. As long as use is not set to be NULL, its argumenta will be chosen fisrt. One can specify a different number of maximum lags by setting use accordingly.

### Value

| | |
|---|---|
| teststat | The test statistic. |
| cval | The critical values that are tabulated in Carrion-i-Silvestre and Sanso, A. (2007). |
| bpoint1 | The first breaking point that corresponds to the teststat. |
| bpoint2 | The second breaking point that corresponds to the teststat. |
| timeElapse | Time elapsed for sequential search. |

## Author(s)

Ho Tsung-wu <tsungwu@ntnu.edu.tw>, College of Management, National Taiwan Normal University.

## References

Carrion-i-Silvestre, J. L. and Sanso, A. (2006) A guide to the computation of stationarity tests. *Empirical Economics*, 31(2), 433-448.

Carrion-i-Silvestre, J. L. and Sanso, A. (2007) The KPSS test with two structural breaks,*Spanish Economic Review*, 9(2), 105-127.

Kwiatkowski, D., Phillips, P.C.B., Schmidt, P. and Shin, Y. (1992) Testing the Null Hypothesis of Stationarity Against the Alternative of a Unit Root: How Sure Are We That Economic Time Series Have a Unit Root? *Journal of Econometrics*, 54, 159-178.

Kurozumi, E. (2002) Testing for stationarity with a break. *Journal of Econometrics*,108(1), 105-127.

## Examples

```
data(macro)


y=macro[1:200,"INF"]

KPSS2=kpss_2br(y,model=1,use=c("nw","ba"))
KPSS2$teststat
KPSS2$cval
y[KPSS2$bpoint,]
```

---

Kurozumi_Bartlett       *Bartlett Kernel for Consistent Estimate of Long-run Variance*

---

## Description

Compute the Bartlett kernel proposed by Kurozumi (2002) to obtains consistent estimate of long-run variance.

## Usage

```
Kurozumi_Bartlett(e)
```

## Arguments

| | |
|---|---|
| e | data that needs to compute consistent long-run variance, normally, regression residuals |

**Value**

Return the consistent estimate of long-run variance, Bartlett kernel proposed by Kurozumi (2002).

**Author(s)**

Ho Tsung-wu <tsungwu@ntnu.edu.tw>, College of Management, National Taiwan Normal University.

**References**

Kurozumi, E. (2002) Testing for stationarity with a break. *Journal of Econometrics*,108(1), 105-127.

**Examples**

```
data(macro)
y=macro[,"INF"]
e=y-mean(y)
Kurozumi_Bartlett(e)
```

---

Kurozumi_QS                     *Quadratic Spectral Kernel for Consistent Estimate of Long-run Variance*

---

**Description**

Compute the Quadratic Spectral kernel proposed by Kurozumi (2002) to obtains consistent estimate of long-run variance.

**Usage**

```
Kurozumi_QS(e)
```

**Arguments**

e               data that needs to compute consistent long-run variance, normally, regression residuals.

**Value**

Return the consistent estimate of long-run variance, Quadratic Spectral kernel proposed by Kurozumi (2002).

**Author(s)**

Ho Tsung-wu <tsungwu@ntnu.edu.tw>, College of Management, National Taiwan Normal University.

**References**

Kurozumi, E. (2002) Testing for stationarity with a break. *Journal of Econometrics*,108(1), 105-127.

**Examples**

```
data(macro)
y=macro[,"INF"]
e=y-mean(y)
Kurozumi_QS(e)
```

---

| mdchlet | *Modified Dirichlet Kernel for Consistent Estimate of Long-run Variance* |
|---|---|

---

**Description**

Computes the modified Dirichlet window to obtain consistent estimate of long-run variance of multivariate time series.

**Usage**

```
mdchlet(data,v)
```

**Arguments**

| | |
|---|---|
| data | Data matrix for computing consistent long-run variance, normally, multivariate regression residuals. |
| v | Number of autocovariance terms in the kernel. |

**Value**

Return the consistent estimate of long-run variance. This procedure handles both multivariate and single time series, which is basically designed for "fmvar","fmgmm" and "fmols".

**Author(s)**

Ho Tsung-wu <tsungwu@ntnu.edu.tw>, College of Management, National Taiwan Normal University.

**References**

Brillinger, David R. (1981) *Time Series Data Analysis and Theory*. San Francisco, CA: Holden-Day.

**Examples**

```
data(macro)
e=apply(macro, 2, function(x) x-mean(x))
mdchlet(e,v=15)
```

---

parzen                    *Parzen Kernel for Consistent Estimate of Long-run Variance*

---

**Description**

Compute the Parzen window to obtain consistent estimate of long-run variance of multivariate time series.

**Usage**

```
parzen(data,v)
```

**Arguments**

| | |
|---|---|
| data | Data matrix for computing consistent long-run variance, normally, multivariate regression residuals. |
| v | Number of autocovariance terms in the kernel. |

**Value**

Return the consistent estimate of long-run variance. This procedure handles both multivariate and single time series, which is basically designed for "fmvar","fmgmm" and "fmols".

**Author(s)**

Ho Tsung-wu <tsungwu@ntnu.edu.tw>, College of Management, National Taiwan Normal University.

**References**

Brillinger, David R. (1981) *Time Series Data Analysis and Theory*. San Francisco, CA: Holden-Day.

**Examples**

```
data(macro)
e=apply(macro, 2, function(x) x-mean(x))
parzen(e,v=15)
```

---

Parzen_uni                    *Parzen Kernel for Consistent Estimate of Long-run Variance*

---

### Description

Compute the Parzen kernel to obtain consistent estimate of long-run variance.

### Usage

```
Parzen_uni(e,v)
```

### Arguments

e               A univariate time series for computing consistent long-run variance, normally,
                regression residuals.

v               Number of lag terms used to compute the long-run variance.

### Value

Return the consistent estimate of long-run variance, that PP and KPSS tests require. This procedure
handles single time series only.

### Author(s)

Ho Tsung-wu <tsungwu@ntnu.edu.tw>, College of Management, National Taiwan Normal University.

### References

Brillinger, David R. (1981) *Time Series Data Analysis and Theory*. San Francisco, CA: Holden-Day.

### Examples

```
data(macro)
y=macro[,"INF"]
e=y-mean(y)
Parzen_uni(e,v=15)
```

---

| pp | *Phillips and Perron Unit Root Test* |
|---|---|

---

### Description

Implement the Phillips-Perron (1988) PP unit root test, including both Za (Z-alpha) and Zt (Z-tau) statistics. This wrapper allows inputting additional deterministic part, for example season dummies, but the asymptotic critical values are not available.

### Usage

```
pp(y,type=c("none","const","trend"),d=NULL,lags=c("short","long","nill"),use=c("nw","ba"))
```

### Arguments

| | |
|---|---|
| y | Vector to be tested for a unit root. |
| type | The deterministic parts in the test regression. |
| d | Additional deterministic parts in addition to "type"" in the test regression. |
| lags | Lags used for correction of error term. See section "details" below. |
| use | User specified lags for correction of error term. See section "details" below. The default is the lag determined by Newey-West bandwidth ("nw") with Bartlett kernel ("ba"). |

### Details

lags="short" sets the number of lags to $\sqrt[4]{4 \times (n/100)}$, whereas lags="long" sets the number of lags to $\sqrt[4]{12 \times (n/100)}$. If lags="nil" is choosen, no error correction is made.

Furthermore, "lags" and "use" are mutually exclusive: As long as "use" is not set to be NULL, its argument will be chosen first. One can specify a different number of maximum lags by setting "use" accordingly. Users can input number of your souce. This version suports two bandwidth functions: "nw" for Newey-West and "and" for Andrews. The kernel functions are supported: "ba"=Bartlett, "pa"=Parzen, "qs"=Qudratic Spectral

### Value

| | |
|---|---|
| Zt | The Z-tau test statistic. |
| cvZt | Critical values of Zt. |
| Za | The Z-alpha test statistic. |
| cvZa | Critical values of Za. |
| lag | Number of lags used for kernel function. |
| resid | Regression residuals. |

**Note**

This code modifies function ur.pp of package urca, which does not have relevant critical values for "Z-alpha" test statistic.

**Author(s)**

Ho Tsung-wu <tsungwu@ntnu.edu.tw>, College of Management, National Taiwan Normal University.

**References**

Phillips, P.C.B. and Perron, P. (1988) Testing for a unit root in time series regression. *Biometrika*, 75(2), 335-346.
MacKinnon, J.G. (1991) Critical Values for Cointegration Tests- Long-Run Economic Relationships, eds. R.F. Engle and C.W.J. Granger, London, Oxford, 267-276.

**Examples**

```
data(macro)
y=macro[,"INF"]
pp(y,
   type=c("none","const","trend")[3],
   lags = c("short", "long", "nil")[2],
   use=c("nw","ba")) # If argument "use" is NOT NULL, argument lags will be ignored.

pp(y,lags = c("short", "long", "nil")[2],
   type=c("none","const","trend")[3],
   use=NULL)

pp(y,lags = c("short", "long", "nil")[2],
   type=c("none","const","trend")[3],
   use=18)
```

---

qs                          *Quadratic-Spectral Kernel for Consistent Estimate of Long-run Variance*

---

**Description**

Computes the Andrews (1991) Quadratic-Spectral window to obtain consistent estimate of long-run variance of multivariate time series.

**Usage**

```
qs(data,v)
```

## Arguments

| | |
|---|---|
| `data` | Data matrix for computing consistent long-run variance, normally, multivariate regression residuals. |
| `v` | Number of autocovariance terms in the kernel. |

## Value

Return the consistent estimate of long-run variance. This procedure handles both multivariate and single time series, which is basically designed for "fmvar","fmgmm" and "fmols".

## Author(s)

Ho Tsung-wu <tsungwu@ntnu.edu.tw>, College of Management, National Taiwan Normal University.

## References

Andrews, D. W. K. (1991) Heteroskedasticity and Autocorrelation Consistent Covariance Matrix Estimation. *Econometrica*, 59, 817-858.

Brillinger, David R. (1981) *Time Series Data Analysis and Theory*. San Francisco, CA: Holden-Day.

## Examples

```
data(macro)
e=apply(macro, 2, function(x) x-mean(x))

qs(e,v=15)
```

---

| QS_uni | *Quadratic Spectral Kernel for Consistent Estimate of Long-run Variance* |
|---|---|

---

## Description

Compute the QS kernel to obtain consistent estimate of long-run variance.

## Usage

```
QS_uni(e,v)
```

## Arguments

| | |
|---|---|
| `e` | A univariate time series for computing consistent long-run variance, normally, regression residuals. |
| `v` | Number of lag terms used to compute the long-run variance. |

**Value**

Return the consistent estimate of long-run variance, that PP and KPSS tests require. This procedure handles single time series only.

**Author(s)**

Ho Tsung-wu <tsungwu@ntnu.edu.tw>, College of Management, National Taiwan Normal University.

**References**

Brillinger, David R. (1981) *Time Series Data Analysis and Theory*. San Francisco, CA: Holden-Day.

**Examples**

```
data(macro)
y=macro[,"INF"]
e=y-mean(y)
QS_uni(e,v=15)
```

---

reisz                          *Reisz Kernel for Consistent Estimate of Long-run Variance*

---

**Description**

Computes the Reisz Bochner window to obtain consistent estimate of long-run variance of multivariate time series.

**Usage**

```
reisz(data,v)
```

**Arguments**

| | |
|---|---|
| data | Data matrix for computing consistent long-run variance, normally, multivariate regression residuals. |
| v | Number of autocovariance terms in the kernel. |

**Value**

Return the consistent estimate of long-run variance. This procedure handles both multivariate and single time series, which is basically designed for "fmvar","fmgmm" and "fmols".

**Author(s)**

Ho Tsung-wu <tsungwu@ntnu.edu.tw>, College of Management, National Taiwan Normal University.

**References**

Brillinger, David R. (1981) *Time Series Data Analysis and Theory*. San Francisco, CA: Holden-Day.

**Examples**

```
data(macro)
e=apply(macro, 2, function(x) x-mean(x))
reisz(e,v=15)
```

---

SPC_Bartlett                                  *Bartlett Kernel for Consistent Estimate of Long-run Variance*

---

**Description**

Compute the Bartlett kernel proposed by Sul, Phillips and Choi (2003) to obtains consistent estimate of long-run variance.

**Usage**

```
SPC_Bartlett(e,v)
```

**Arguments**

| | |
|---|---|
| e | data that needs to compute consistent long-run variance, normally, regression residuals. |
| v | Number of lag terms to use when computing the long-run variance. |

**Value**

Return the consistent estimate of long-run variance, Bartlett kernel proposed by Sul, Phillips and Choi (2003) .

**Author(s)**

Ho Tsung-wu <tsungwu@ntnu.edu.tw>, College of Management, National Taiwan Normal University.

**References**

Carrion-i-Silvestre, J. L. and Sanso, A. (2006) A guide to the computation of stationarity tests.*Empirical Economics*, 31(2), 433-448.
Carrion-i-Silvestre, J. L. and Sanso, A. (2007) The KPSS test with two structural breaks. *Spanish Economic Review*, 9(2), 105-127.
Sul, D., Phillips, P.C.B., and Choi, C.Y.(2005) Prewhitening Bias in HAC Estimation. *Oxford Bulletin of Economics and Statistics*, 67(4), 517-546.

## Examples

```
data(macro)
y=macro[,"INF"]
e=y-mean(y)
SPC_Bartlett(e,v=15)
```

---

| SPC_QS | *Quadratic Spectral Kernel for Consistent Estimate of Long-run Variance* |
|---|---|

---

## Description

Compute the Quadratic Spectral kernel of Sul, Phillips and Choi (2003) to obtains consistent estimate of long-run variance.

## Usage

```
SPC_QS(e,v)
```

## Arguments

e      data that needs to compute consistent long-run variance, normally, regression residuals.

v      Number of lag terms to use when computing the long-run variance.

## Value

Return the consistent estimate of long-run variance.

## Author(s)

Ho Tsung-wu <tsungwu@ntnu.edu.tw>, College of Management, National Taiwan Normal University.

## References

Carrion-i-Silvestre, J. L. and Sanso, A. (2006) A guide to the computation of stationarity tests.*Empirical Economics*, 31(2), 433-448.
Carrion-i-Silvestre, J. L. and Sanso, A. (2007) The KPSS test with two structural breaks. *Spanish Economic Review*, 9(2), 105-127.
Sul, D., Phillips, P.C.B., and Choi, C.Y.(2005) Prewhitening Bias in HAC Estimation. *Oxford Bulletin of Economics and Statistics*, 67(4), 517-546.

## Examples

```
data(macro)
y=macro[,"INF"]
e=y-mean(y)
SPC_QS(e,v=15)
```

---

sw                              *Stock-Watson Common Trends Statistic*

---

### Description

Computes Stock and Watson (1988) common trends statistic for the null hypothesis that the data is
a noncointegrated system (after allowing for a p-th order polynomial time trend).

### Usage

```
sw(data,p,v=15,ker_fun="parzen",aband=0,filter=0)
```

### Arguments

| | |
|---|---|
| data | Matrix of k-time series variables. |
| p | Order of the time polynomial in the null hypothesis. |
| v | Number of autocovariance terms to compute the spectrum at frequency zero, default=15. |
| ker_fun | Set kernel function to one of the available kernels, default="parzen". See section `details` below. |
| aband | Whether to activate the automatic bandwidth selection.<br>aband=1. To activate.<br>aband=0. Do not activate. The default. |
| filter | Whether to use an AR(1) filter to compute the spectrum at frequency zero.<br>filter=1. To use.<br>filter=0. Do not use. The default. |

### Details

1. Available kernels. Technical details are referred to Brillinger (1981,P.55)
"parzen"=Parzen kernel
"fejer"=Bartlett kernel
"dchlet"= Dirichlet kernel
"mdchlet"= Modified Dirichlet kernel
"tukham"=Tukey-Hamming kernel
"tukhan"=Tukey-Hanning kernel
"cauchy"=Cauchy kernel
"bohman"=Bohman kernel
"reisz"=Riesz,Bochner kernel
"gw"= Gauss-Weierstrass kernel

"qs"= Andrews (1991) Quadratic-Spectral

These kernels are written for FM procedures, technically different from those used in `pp` and `kpss` tests.

2. Andrews (1991) has developed data based (or automatic) bandwidth procedures for computing the spectrum. `COINT` implements these procedures for the Parzen, Bartlette, Tukey-Hamming, and the Quadratic-Spectral kernels. When aband is active, `COINT` ignores the value you specify for the band-width parameter and automatically substitutes the data-based value.
3. The aim of the AR(1) filter is to flatten the spectrum of residual around the zero frequency, thereby making it easier to estimate the true spectrum by simple averaging of the periodogram.

### Value

sw_stat          Test statistic. Reject the null of a unit root if the SW statistic < critical value

sw_cv            Critical values.

### Author(s)

Ho Tsung-wu <tsungwu@ntnu.edu.tw>, College of Management, National Taiwan Normal University.

### References

Stock, J. & M. K. Watson (1988) Testing for Common Trends. *Journal of the American Statistical Association*, 83, 1097-1107.

### Examples

```
data(macro)
sw(macro,p=1,v=15)
```

---

tukham                          *Tukey-Hamming Kernel for Consistent Estimate of Long-run Variance*

---

### Description

Compute the Tukey-Hamming window to obtain consistent estimate of long-run variance of multi-variate time series.

### Usage

```
tukham(data,v)
```

## Arguments

| | |
|---|---|
| data | Data matrix for computing consistent long-run variance, normally, multivariate regression residuals. |
| v | Number of autocovariance terms in the kernel. |

## Value

Brillinger, David R. (1981) *Time Series Data Analysis and Theory*. San Francisco, CA: Holden-Day.

## Author(s)

Ho Tsung-wu <tsungwu@ntnu.edu.tw>, College of Management, National Taiwan Normal University.

## References

Brillinger, David R. (1981) Time Series Data Analysis and Theory. San Francisco, CA: Holden-Day.

## Examples

```
data(macro)
e=apply(macro, 2, function(x) x-mean(x))
tukham(e,v=15)
```

---

tukhan                              *Tukey-Hanning Kernel for Consistent Estimate of Long-run Variance*

---

## Description

Compute the Tukey-Hanning window to obtain consistent estimate of long-run variance of multivariate time series.

## Usage

```
tukhan(data,v)
```

## Arguments

| | |
|---|---|
| data | Data matrix for computing consistent long-run variance, normally, multivariate regression residuals. |
| v | Number of autocovariance terms in the kernel. |

## Value

Return the consistent estimate of long-run variance. This procedure handles both multivariate and single time series, which is basically designed for "fmvar","fmgmm" and "fmols".

## Author(s)

Ho Tsung-wu <tsungwu@ntnu.edu.tw>, College of Management, National Taiwan Normal University.

## References

Brillinger, David R. (1981) *Time Series Data Analysis and Theory*. San Francisco, CA: Holden-Day.

## Examples

```
data(macro)
e=apply(macro, 2, function(x) x-mean(x))
tukhan(e,v=15)
```

---

Za                              *Phillips' (1987) Za and Zt Test for Unit Root*

---

## Description

Compute Phillips' (1987) Za and Zt statistics for the null hypothesis that y has a unit root.

## Usage

```
Za(y,p=1,v=15,ker_fun="parzen",aband=0,filter=0)
```

## Arguments

| | |
|---|---|
| y | The data of dependent variable in a regression. |
| p | Order of the time polynomial in the cointegrating regressio. |
| | p =-1: No deterministic term in the cointegrating regression. |
| | p = 0: For a constant term. |
| | p = 1: For a constant term and trend. Default. |
| | P > 2: For time polynomial. |
| | Critical values are available for p within [1,5]. |
| v | Number of autocovariance terms to compute the spectrum at frequency zero, default=15. |
| ker_fun | Set kernel function to one of the available kernels, default="parzen". See section `details` below. |
| aband | Whether to activate the automatic bandwidth selection. |
| | aband=1. To activate. |
| | aband=0. Do not activate.The default. |
| filter | Whether to use an AR(1) filter to compute the spectrum at frequency zero. |
| | filter=1. To use. |
| | filter=0. Do not use. The default. |

## Value

| | |
|---|---|
| `alpha` | Estimate of the AR(1) coefficient. |
| `za` | Za statistic for the series under the null has a unit root. Reject the null hypothesis of a unit root if the test statistic < critical value. |
| `za_cv` | Critical values of Za. |
| `zt` | Zt statistic for the series under the null has a unit root. Reject the null hypothesis of a unit root if the test statistic < critical value. |
| `zt_cv` | Critical values of Zt. |

## Author(s)

Ho Tsung-wu <tsungwu@ntnu.edu.tw>, College of Management, National Taiwan Normal University.

## References

Ouliaris, S., J. Y. Park, and P. C. B. Phillips (1989) Testing for a Unit Root in the Presence of a Maintained Trend. Ch. 1 in Baldev Raj (ed.), *Advances in Econometrics and Modelling*. Netherlands: Kluwer Academic Publishers.
Phillips, P. C. B. (1987) Time Series Regression with a Unit Root. *Econometrica*, 55, 277-301.

## Examples

```
data(macro)
y=macro[,1]
Za(y,p=1,v=10)
```

---

ZA_1br                          *Zivot-Andrews unit root test with unknown one structural break.*

---

## Description

This function implements Zivot-Andrews sequential ADF unit root test with unknown one structural break. Handling two outlier models: "Innovational outlier" and "Additive outlier".

## Usage

```
ZA_1br(y,
      model=c("intercept", "trend", "both"),
      outlier=1,
      pmax=8,
      ic=c("AIC","BIC"),
      fixed=FALSE,
      trim=0.1,
      eq=1,
      season=FALSE)
```

## Arguments

| | |
|---|---|
| y | Univariate time series data, a preferable format is ts when season=TRUE. |
| model | Modelling where the unknown structural change occurs.<br>intercept= structural change occurs at the intercept.<br>trend= structural change occurs at the trend.<br>both= structural changes occur at both the intercept and the trend. |
| outlier | The outlier model.<br>1=Innovational outlier model.<br>2=Additive outlier model. |
| pmax | The maximal lags that are either included in the test regression or lag selection searches its optimal lag via "ic". |
| ic | Information criteria, "AIC" or "BIC". The default is "AIC". |
| fixed | Logical. If TURE, pmax is the fixed inputed lags. If FALSE, pmax is the maximal lags where lag selection searches its optimal lag. |
| trim | The trimming percentage. Default is 10 |
| eq | The type of dependent variable in ADF equation.<br>1= original y. 2= differenced y. |
| season | Logical. If TURE,then seasonal dummies will be included in the test regression. |

## Value

| | |
|---|---|
| teststat | The Zivot-Andrews test statistic, which is the min(tstats). |
| cval | The critical values that are tabulated in Zivot and Andrews(1992) |
| p | The number of lags that are included in the test regression. |
| bpoint | The breaking point that corresponds to the teststat. |
| tstats | The sequential ADF test statistic. |
| testreg | The lm() output that corresponds to teststat. |
| timeElapse | Time elapsed for sequential search. |

## Note

This code modifies function ur.za of package urca. We add "season", "eq", "outlier",and "trim". Specifically, "outlier" is crucial, "season" is left to advanced research.

## Author(s)

Ho Tsung-wu <tsungwu@ntnu.edu.tw>, College of Management, National Taiwan Normal University.

## References

Zivot,E. and Andrews, W.K. (1992) Further Evidence on the Great Crasch, the Oil-Price Shock, and the Unit-Root Hypothesis. *Journal of Business & Economic Statistics*,10(3), 251-270.

## Examples

```
data(macro) #US inflation rate, 1958M1-2025M7
y=macro[1:200,"INF"]
za1=ZA_1br(y,
           ic=c("AIC","BIC")[2],
           outlier=1,
           pmax=8,
           fixed=TRUE,
           model=c("intercept","trend","both")[1],
           trim=0.01,
           eq=1,
           season=TRUE)
za1$timeElapse[3]
za1$teststat
za1$cval
y[za1$bpoint,]
za1$tstats
za1$p

#plotting
plot.ts(za1$tstats,ylim=range(c(za1$tstats,za1$cval)))
abline(h=za1$cval[1],col="red")
abline(h=za1$cval[2],col="blue")
abline(h=za1$cval[3],col="green")
abline(v=za1$bpoint,col="red",lty=2)
```

---

ZA_2br                          *Zivot-Andrews unit root test with unknown one structural break.*

---

## Description

This function implements Zivot-Andrews sequential ADF unit root test with one unknown structural break. Handling two outlier models: "Innovational outlier" and "Additive outlier".

## Usage

```
ZA_2br(y,
      model=c("intercept", "both"),
      pmax=8,
      ic=c("AIC","BIC"),
      fixed=TRUE,
      trim=0.1,
      eq=1,
      trace=TRUE,
      season=FALSE)
```

## Arguments

| | |
|---|---|
| y | Univariate time series data, a preferable format is ts when "season=TRUE". |
| model | Modelling where the unknown structural change occurs.<br>intercept= structural change occurs at the intercept.<br>trend= structural change occurs at the trend.<br>both= structural changes occur at both the intercept and the trend. |
| pmax | The maximal lags that are either included in the test regression or lag selection searches its optimal lag via "ic". |
| ic | Information criteria, "AIC" or "BIC". The default is "AIC". |
| fixed | Logical. If TURE, pmax is the fixed inputed lags, and the default is TRUE.<br>If FALSE, pmax is the maximal lags where lag selection searches its optimal lag. |
| trim | The trimming percentage. Default is 10 |
| eq | The type of dependent variable in ADF equation.<br>1= original y.<br>2= differenced y. |
| trace | Logical. If TURE, then screen displays the sequential progress. |
| season | Logical. If TURE,then seasonal dummies will be included in the test regression, and y must be in ts format. |

## Details

This code entends Zivot-Andrews (1992) sequential procedure to two unknown structural changes. Critical values are from Narayan and Popp (2010).

## Value

| | |
|---|---|
| teststat | The ADF test statistic in the presence of two structural breaks. |
| cval | The critical values that are tabulated in Narayan and Popp (2010). |
| p | The number of lags that are included in the test regression. |
| bpoint1 | The first breaking point that corresponds to the teststat. |
| bpoint2 | The second breaking point that corresponds to the teststat. |
| timeElapse | Time elapsed for sequential search. |

## Note

This code modifies function ur.za of package urca. We add "season", "eq", "outlier",and "trim". Specifically, "outlier" is crucial, "season" is left to advanced research.

## Author(s)

Ho Tsung-wu <tsungwu@ntnu.edu.tw>, College of Management, National Taiwan Normal University.

## References

Narayan, P. K. and Popp, S. (2010) A new unit root test with two structural breaks in level and slope at unknown time. *Journal of Applied Statistics*,37, 1425-1438.

Zivot,E. and Andrews, W.K. (1992),Further Evidence on the Great Crasch, the Oil-Price Shock, and the Unit-Root Hypothesis. *Journal of Business & Economic Statistics*,10(3), 251-270.

## Examples

```
data(macro) # US macro data, 1967M1-2025M7
# It takes time

y=macro[1:200,"INF"]
za2=ZA_2br(y,
           ic=c("AIC","BIC")[2],
           pmax=8,
           fixed=TRUE,
           model=c("intercept","trend","both")[1],
           trim=0.1,
           eq=1,
           season=TRUE)
za2$timeElapse[3]/60
za2$teststat
za2$cval
y[za2$bpoint1,] #The first dated strictural change
y[za2$bpoint2,] #The second dated strictural change
```

# Index