Package ‘apt’

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Description Asymmetric price transmission between two time series is assessed. Several functions are available for linear and nonlinear threshold cointegration, and furthermore, symmetric and asymmetric error correction model.
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Asymmetric price transmission between two time series is assessed. The names of functions and datasets reveal the categories they belong to. A prefix of da is for datasets, ci for cointegration, and ecm for error correction model.

The focus is on the price transmission between two price variables. Therefore, objectives like fitting an error correction model for more than two variables are beyond the scope of this package.

Details

| Package: | apt          |
| Type:    | Package      |
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Author(s)

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Description

Fit a threshold cointegration regression between two time series.

Usage

```r
ciTARFit(y, x, model = c('tar', 'mtar'), lag = 1, thresh = 0, small.win = NULL)
```
Arguments

- **y**: dependent or left-side variable for the long-run model; must be a time series object.
- **x**: independent or right-side variable for the long-run model; must be a time series object.
- **model**: a choice of two models: `tar` or `mtar`; the default is `tar`.
- **lag**: number of lags for the threshold cointegration regression.
- **thresh**: a threshold value (default of zero).
- **small.win**: value of a small window for fitting the threshold cointegration regression; used mainly for lag selection in `ciTarLag`.

Details

This is the main function for threshold autoregression regression (TAR) in assessing the nonlinear threshold relation between two time series variables. It can be used to estimate four types of threshold cointegration regressions. These four types are TAR with a threshold value of zero; consistent TAR with a nonzero threshold; MTAR (momentum TAR) with a threshold value of zero; and consistent MTAR with a nonzero threshold. The option of small window will be used in lag selection because a comparison of AIC and BIC values should be based on the same number of regression observations.

Value

Return a list object of class "ciTarFit" with these components:

- **y**: dependent variable
- **x**: independent variable
- **model**: model choice
- **lag**: number of lags
- **thresh**: threshold value
- **data.LR**: data used in the long-run regression
- **data.CI**: data used in the threshold cointegration regression
- **z**: residual from the long-run regression
- **lz**: lagged residual from the long-run regression
- **ldz**: lagged residual with 1st difference from long-run model
- **LR**: long-run regression
- **CI**: threshold cointegration regression
- **f.phi**: test with a null hypothesis of no threshold cointegration
- **f.apt**: test with a null hypothesis of no asymmetric price transmission in the long run
- **sse**: value of sum of squared errors
- **aic**: value of Akaike Information Criterion
- **bic**: value of Bayesian Information Criterion.
Methods

One method is defined as follows:

print: Four main outputs from threshold cointegration regression are shown: long-run regression between the two price variables, threshold cointegration regression, hypothesis test of no cointegration, and hypothesis test of no asymmetric adjustment.

Author(s)

Changyou Sun (<cs258@msstate.edu>)

References


See Also

summary.ciTARFit; ciTarLag for lag selection; and ciTarThd for threshold selection.

Examples

# see example at daVich

---

ciTARLag

Lag Selection for Threshold Cointegration Regression

Description

Select the best lag for threshold cointegration regression by AIC and BIC

Usage

ciTARLag(y, x, model = c("tar", "mtar"), maxlag = 4, thresh = 0, adjust = TRUE)
**Arguments**

- **y**: dependent or left-side variable for the long-run regression.
- **x**: independent or right-side variable for the long-run regression.
- **model**: a choice of two models, either tar or mtar.
- **maxlag**: maximum number of lags allowed in the search process.
- **thresh**: a threshold value.
- **adjust**: logical value (default of TRUE) of whether to adjust the window widths so all regressions by lag have the same number of observations.

**Details**

Estimate the threshold cointegration regressions by lag and then select the best regression by AIC or BIC value. The longer the lag, the smaller the number of observations available for estimation. If the windows of regressions by lag are not adjusted, the maximum lag is usually the best lag by AIC or BIC. Theoretically, AIC and BIC from different models should be compared on the basis of the same observation numbers (Ender 2004). adjust shows the effect of this adjustment on the estimation window. By default, the value of adjust should be TRUE.

**Value**

Return a list object of class "ciTarLag" with the following components:

- **path**: a data frame of model criterion values by lag, including lag for the current lag, totObs for total observations in the raw data, coinObs for observations used in the cointegration regression, sse for the sum of squared errors, aic for AIC value, bic for BIC value, LB4 for the p-value of Ljung_Box Q statistic with 4 autocorrelation coefficients, LB8 with 8 coefficients, LB12 for Q statistic with 12 coefficients.

- **out**: a data frame of the final model selection, including the values of model, maximum lag, threshold value, best lag by AIC, best lag by BIC.

**Methods**

Two methods are defined as follows:

- **print**: This shows the out component in the returned list.
- **plot**: This demonstrates the trend of AIC and BIC changes of threshold cointegration regressions by lag. It facilitates the selection of the best lag for a threshold cointegration model.

**Author(s)**

Changyou Sun (<cs258@msstate.edu>)

**References**


See Also

ciTarFit; and ciTarThd;

Examples

# see example at daVich

ciTarThd

Threshold Selection for Threshold Cointegration Regression

Description

Select the best threshold for threshold cointegration regression by sum of squared errors

Usage

`ciTarThd(y, x, model = c('tar', 'mtar'), lag = 1, th.range = 0.15, digits = 3)`

Arguments

- `y`: dependent or left-side variable for the long-run regression.
- `x`: independent or right-side variable for the long-run regression.
- `model`: a choice of two models, either tar or mtar.
- `lag`: number of lags.
- `th.range`: the percentage of observations to be excluded from the search.
- `digits`: number of digits used in rounding outputs.

Details

The best threshold is determined by fitting the regression for possible threshold values, sorting the results by sum of squared errors (SSE), and selecting the best with the lowest SSE. To have sufficient observations on either side of the threshold value, certain percentage of observations on the top and bottoms are excluded from the search path. This is usually set as 0.15 by the `th.range` (Chan 1993).

Value

Return a list object of class "ciTarThd" with the following components:

- `model`: model choice
- `lag`: number of lags
- `th.range`: the percentage of observations excluded
- `th.final`: the best threshold value
- `ssef`: the best (i.e., lowest) value of SSE
obs.tot     total number of observations in the raw data
obs.CI      number of observations used in the threshold cointegration regression
basic       a brief summary of the major outputs
path        a data frame of the search record (number of regression, threshold value, SSE, AIC, and BIC values).

Methods

Two methods are defined as follows:

print:  This shows the basic component in the returned list object.
plot:  plotting three graphs in one window; they reveals the relationship between SSE (sum of
        squared errors), AIC, BIC and the threshold values. The best threshold value is associated
        with the lowest SSE value.

Author(s)

Changyou Sun (<cs258@msstate.edu>)

References

Chan, K.S. 1993. Consistency and limiting distribution of the least squares estimator of a threshold
Enders, W., and C.W.J. Granger. 1998. Unit-root tests and asymmetric adjustment with an example

See Also

ciTarFit; and ciTarLag

Examples

# see example at daVich

Description

This data set contains two unit import prices (dollar per piece) and values (million dollars) of
wooden beds from Vietnam and China to the United States.

price.ch     Monthly price over January 2002 to January 2010 from China.
price.ch     Monthly value over January 2002 to January 2010 from China.
Usage
data(daVich)

Format
A monthly time series from January 2002 to January 2010 with 97 observations for each of the four series.

Details
Under the Harmonized Tariff Schedule (HTS) system, the commodity of wooden beds is classified as HTS 9403.50.9040. The monthly cost-insurance-freight values in dollar and quantities in piece are reported by country from U.S. ITC (2010). The unit price (dollar per piece) is calculated as the ratio of value over quantity by country.

Source

References

Examples

# The following codes reproduce the main results in Sun (2011 FPE).
# All the codes have been tested and should work.

# 1. Data preparation __________________________________________________________
library(urca); data(daVich)
head(daVich); tail(daVich); str(daVich)
prVi <- y <- daVich[, 1]
prCh <- x <- daVich[, 2]

# 2. EG cointegration _________________________________________________________
LR <- lm(y ~ x); summary(LR)
(LR.coef <- round(summary(LR)$coefficients, 3))
(ry <- ts(residuals(LR), start=start(prCh), end=end(prCh), frequency =12))
summary(eg <- ur.df(ry, type=c("none"), lags=1)); plot(eg)
(eg4 <- Box.test(eg@res, lag = 4, type="Ljung") )
(eg8 <- Box.test(eg@res, lag = 8, type="Ljung") )
(eg12 <- Box.test(eg@res, lag = 12, type="Ljung") )

## Not run:
# 3. TAR + Cointegration

## best threshold

```r
t3 <- ciTarThd(y=prVi, x=prCh, model="tar", lag=0)
(th.tar <- t3$basic); plot(t3)
for (i in 1:12) {  # 20 seconds
t3a <- ciTarThd(y=prVi, x=prCh, model="tar", lag=i)
th.tar[i+2] <- t3a$basic[,2]
}  # th.tar

t4 <- ciTarThd(y=prVi, x=prCh, model="mtar", lag=0); (th.mtar <- t4$basic)
plot(t4)
for (i in 1:12) {
t4a <- ciTarThd(y=prVi, x=prCh, model="mtar", lag=i)
th.mtar[i+2] <- t4a$basic[,2]
}  # th.mtar
```

# The following threshold values are specific to this data. They HAVE TO be revised for another data set. Otherwise, various errors will occur.

```r
t.tar <- -8.041; t.mtar <- -0.451  # lag = 0 to 4
t.tar <- -8.701; t.mtar <- -0.451  # lag = 5 to 12
```

## lag selection

```r
mx <- 12
(g1 <- ciTarLag(y=prVi, x=prCh, model="tar", maxlag=mx, thresh= 0)); plot(g1)
(g2 <- ciTarLag(y=prVi, x=prCh, model="mtar",maxlag=mx, thresh= 0)); plot(g2)
(g3 <- ciTarLag(y=prVi, x=prCh, model="tar", maxlag=mx, thresh=t.tar)); plot(g3)
(g4 <- ciTarLag(y=prVi, x=prCh, model="mtar",maxlag=mx, thresh=t.mtar)); plot(g4)
```

## Table 3 Results of EG and threshold cointegration tests

# Note: Some results in Table 3 in the published paper were incorrect because of a mistake made when the paper was done in 2009. I found the mistake when the package was build in later 2010. For example, for the consistent MTAR, the coefficient for the positive term was reported as -0.251 (-2.130) but it should be -0.106 (-0.764), as calculated from below codes. The main conclusion about the research issue is still qualitatively the same.

```r
vv <- 3
(f1 <- ciTarFit(y=prVi, x=prCh, model="tar", lag=vv, thresh=0 ))
(f2 <- ciTarFit(y=prVi, x=prCh, model="tar", lag=vv, thresh=t.tar ))
(f3 <- ciTarFit(y=prVi, x=prCh, model="mtar", lag=vv, thresh=0 ))
(f4 <- ciTarFit(y=prVi, x=prCh, model="mtar", lag=vv, thresh=t.mtar))
```

```r
r0 <- cbind(summary(f1)$dia, summary(f2)$dia, summary(f3)$dia,
summary(f4)$dia)
diag <- r0[cb(1:4, 6:7, 12:14, 8, 9, 11), c(1,2,4,6,8)]
rownames(diag) <- 1:nrow(diag); diag
e1 <- summary(f1)$out; e2 <- summary(f2)$out
e3 <- summary(f3)$out; e4 <- summary(f4)$out; rbind(e1, e2, e3, e4)
```
ee <- list(e1, e2, e3, e4); vect <- NULL
for (i in 1:4) {
  ef <- data.frame(ee[i])
  vect2 <- c(paste(ef[3, "estimate"], ef[3, "sign"], sep=""),
             paste(" ", ef[3, "t.value"], " " , sep=""),
             paste(ef[4, "estimate"], ef[4, "sign"], sep=""),
             paste(" ", ef[4, "t.value"], " " , sep=""))
  vect <- cbind(vect, vect2)
}
item <- c("pos.coeff", "pos.t.value", "neg.coeff", "neg.t.value")
ve <- data.frame(cbind(item, vect)); colnames(ve) <- colnames(diag)
(res.CI <- rbind(diag, ve)[c(1:2, 13:16, 3:12), ])
rownames(res.CI) <- 1:nrow(res.CI)

# 4. APT + ECM  

(sem <- ecmSymFit(y=prVi, x=prCh, lag=4)); names(sem)
aem <- ecmAsyFit(y=prVi, x=prCh, lag=4, model="mtar", split=TRUE, thresh=t.mtar)
aem
(ccc <- summary(aem))
coe <- cbind(as.character(ccc[1:19, 2]),
             paste(ccc[1:19, "estimate"], ccc$signif[1:19], sep=""),
             ccc[1:19, "t.value"],
             paste(ccc[20:38, "estimate"], ccc$signif[20:38], sep=""),
             ccc[20:38, "t.value"])
colnames(coe) <- c("item", "China.est", "China.t", "Vietnam.est", "Vietnam.t")
(edia <- ecmDiag(aem, 3))
ed <- edia[1,6,7,8,9, ]
ed2 <- cbind(ed[,1:2], " ", ed[,3], " ")
colnames(ed2) <- colnames(coe)
(tes <- ecmAsyTest(aem)$out)
tes2 <- tes[2, 3, 5, 11, 12, 13, 1, -1]
tes3 <- cbind(as.character(tes2[, 1]),
              paste(tes2[2,2], tes2[2,6], sep=""),
              paste(" ", round(tes2[,4],2), " " , sep=""),
              paste(tes2[2,3], tes2[2,7], sep=""),
              paste(" ", round(tes2[,5],2), " " , sep=""))
colnames(tes3) <- colnames(coe)
(coe <- data.frame(apply(coe, 2, as.character), stringsAsFactors=FALSE))
ed2 <- data.frame(apply(ed2, 2, as.character), stringsAsFactors=FALSE)
tes3 <- data.frame(apply(tes3, 2, as.character), stringsAsFactors=FALSE)
table.4 <- data.frame(rbind(coe, ed2, tes3))
options(width=150); table.4; options(width=80)

## End(Not run)
**Description**

Estimate an asymmetric error correction model (ECM) for two time series.

**Usage**

```r
ecmAsyFit(y, x, lag = 1, split = TRUE, model = c("linear", "tar", "mtar"), thresh = 0)
```

**Arguments**

- `y`: dependent or left-side variable for the long-run regression.
- `x`: independent or right-side variable for the long-run regression.
- `lag`: number of lags for variables on the right side.
- `split`: a logical value (default of TRUE) of whether the right-hand variables should be split into positive and negative parts.
- `model`: a choice of three models: linear, tar, or mtar cointegration.
- `thresh`: a threshold value; this is only required when the model is specified as 'tar' or 'mtar'.

**Details**

There are two specifications of an asymmetric ECM. The first one is how to calculate the error correction terms. One way is through linear two-step Engle Granger approach, as specified by `model = "linear"`. The other two ways are threshold cointegration by either 'tar' or 'mtar' with a threshold value. The second specification is related to the possible asymmetric price transmission in the lagged price variables, as specified in `split = TRUE`. Note that the linear cointegration specification is a special case of the threshold cointegration. A model with `model = "linear"` is the same as a model with `model = "tar", thresh = 0`.

**Value**

Return a list object of class "ecm" and "ecmAsyFit" with the following components:

- `y`: dependent variable
- `x`: independent variable
- `lag`: number of lags
- `split`: logical value of whether the right-hand variables are split
- `model`: model choice
- `IndVar`: data frame of the right-hand variables used in the ECM
- `name.x`: name of the independent variable
- `name.y`: name of the dependent variable
- `ecm.y`: ECM regression for the dependent variable
- `ecm.x`: ECM regression for the independent variable
- `data`: all the data combined for the ECM
- `thresh`: thresh value for TAR and MTAR model
Methods

Two methods are defined as follows:

print: showing the key outputs.
summary: summarizing the key outputs.

Author(s)

Changyou Sun (<cs258@msstate.edu>)

References


See Also

print.ecm; summary.ecm; ecmDiag; and ecmAsyTest.

Examples

# see example at daVich

```r

ecmAsyTest

Hypothesis Tests on Asymmetric Error Correction Model

Description

Conduct several F-tests on the coefficients from asymmetric ECM.

Usage

ecmAsyTest(w, digits = 3)

Arguments

w an object of 'ecmAsyFit' class.
digits number of digits used in rounding outputs.

Details

There are two ECM equations for the two price series. In each equation, four types of hypotheses are tested; equilibrium adjustment path symmetry on the error correction terms (H1), Granger causality test (H2), distributed lag symmetry at each lag (H3), and cumulative asymmetry of all lags (H4). The latter two tests are only feasible and available for models with split variables. The number of H3 tests is equal to the number of lags.
Value

Return a list object with the following components:

- **H1ex**: H01 in equation x: equilibrium adjustment path symmetry
- **H1ey**: H01 in equation y: equilibrium adjustment path symmetry
- **H2xx**: H02 in equation x: x does not Granger cause x
- **H2yx**: H02 in equation y: x does not Granger cause y
- **H2xy**: H02 in equation x: y does not Granger cause x
- **H2yy**: H02 in equation y: y does not Granger cause y
- **H3xx**: H03 in equation x: distributed lag symmetry of x at each lag
- **H3yx**: H03 in equation y: distributed lag symmetry of x at each lag
- **H3xy**: H03 in equation x: distributed lag symmetry of y at each lag
- **H3yy**: H03 in equation y: distributed lag symmetry of y at each lag
- **H4xx**: H04 in equation x: cumulative asymmetry of x for all lags
- **H4yx**: H04 in equation y: cumulative asymmetry of x for all lags
- **H4xy**: H04 in equation x: cumulative asymmetry of y for all lags
- **H4yy**: H04 in equation y: cumulative asymmetry of y for all lags

out summary of the four types of hypothesis tests

Methods

One method is are defined as follows:

- **print**: This shows the `out` component in the returned list object.

Author(s)

Changyou Sun (<cs258@msstate.edu>)

References


See Also

- `ecmAsyFit` and `ecmDiag`.

Examples

# see example at daVich
Description
Report a set of diagnostic statistics for symmetric or asymmetric error correction models

Usage
ecmDiag(m, digits = 2)

Arguments
m  an object of class ecm from the function of ecmAsyFit or ecmSymFit.
digits  number of digits used in rounding outputs.

Details
Compute several diagnostic statistics for each ECM equation. This is mainly used to assess the
serial correlation in the residuals and model adequacy.

Value
Return a data frame object with the following components by equation: R-squared, Adjusted R-
squared, F-statistic, Durbin Watson statistic, p-value for DW statistic, AIC, BIC, and p-value of
Ljung_Box Q statistics with 4, 8, 12 autocorrelation coefficients.

Author(s)
Changyou Sun (<cs258@msstate.edu>)

References

See Also
ecmAsyFit; ecmSymFit; and ecmDiag.

Examples
# see example at daVich
ecmSymFit  

Fitting symmetric Error Correction Model

Description

Estimate a symmetric error correction model (ECM) for two time series.

Usage

ecmSymFit(y, x, lag = 1)

Arguments

y  
dependent or left-side variable for the long-run regression.

x  
independent or right-side variable for the long-run regression.

lag  
number of lags for variables on the right side.

Details

The package apt focuses on price transmission between two series. This function estimates a standard error correction model for two time series. While it can be extended for more than two series, it is beyond the objective of the package now.

Value

Return a list object of class "ecm" and "ecmSymFit" with the following components:

y  
dependent variable

x  
independent variable

lag  
number of lags

data  
all the data combined for the ECM

IndVar  
data frame of the right-hand variables used in the ECM

name.x  
ame of the independent variable

name.y  
name of the dependent variable

ecm.y  
ECM regression for the dependent variable

ecm.x  
ECM regression for the independent variable

Author(s)

Changyou Sun (<cs258@msstate.edu>)

References

See Also

`print.ecm`; `summary.ecm`; `ecmDiag`; and `ecmAsyFit`.

Examples

```r
# see example at daVich
```

[16]

---

**Description**

Show main outputs from symmetric `ecmSymFit` or asymmetric `ecmAsyFit` error correction models.

**Usage**

```r
## S3 method for class 'ecm'
print(x, ...)  
```

**Arguments**

- `x` an object of class `ecm` from the function of `ecmAsyFit` or `ecmSymFit`.
- `...` additional arguments to be passed.

**Details**

This is the print method for `ecmAsyFit` or `ecmSymFit` to show main model outputs.

**Value**

Summary results of the two ECM equations are shown for the two focal price series.

**Author(s)**

Changyou Sun (<cs258@msstate.edu>)

**See Also**

`ecmSymFit` and `ecmAsyFit`.

**Examples**

```r
# see example at daVich
```
Description

This summarizes the main results from threshold cointegration regression.

Usage

```r
## S3 method for class 'ciTarFit'
summary(object, digits=3, ...)
```

Arguments

- `object`: an object of class 'ciTarFit'.
- `digits`: number of digits for rounding outputs.
- `...`: additional arguments to be passed.

Details

This wraps up the outputs from threshold cointegration regression in two data frames, one for diagnostic statistics and the other for coefficients.

Value

A list with two data frames. `dia` contains the main model specifications and hypothesis test results. `out` contains the regression results for both the long run (LR) and threshold cointegration (CI).

Author(s)

Changyou Sun (&lt;cs258@msstate.edu&gt;)

See Also

`ciTarFit`.

Examples

```r
# see example at daVich
```
**Summary of Results from Error Correction Model**

**Description**

This summarizes the main results from error correction models.

**Usage**

```r
## S3 method for class 'ecm'
summary(object, digits=3, ...)
```

**Arguments**

- `object`: an object of class `ecm` from the function of `ecmAsyFit` or `ecmSymFit`.
- `digits`: number of digits for rounding outputs
- `...`: additional arguments to be passed.

**Details**

This wraps up the coefficients and statistics from ECM by equation.

**Value**

A data frame object with coefficients and related statistics by equation.

**Author(s)**

Changyou Sun (<cs258@msstate.edu>)

**See Also**

- `ecmSymFit` and `ecmAsyFit`.

**Examples**

```r
# see example at daVich
```
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