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Type Package

Title Conditional Maximum Likelihood for Quadratic Exponential Models for Binary Panel Data

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Author Francesco Bartolucci (University of Perugia), Claudia Pigini (University of Ancona "Politecnica delle Marche")

Maintainer Francesco Bartolucci <francesco.bartolucci@unipg.it>

Description Estimation, based on conditional maximum likelihood, of the quadratic exponential model proposed by Bartolucci, F. & Nigro, V. (2010, Econometrica) <DOI:10.3982/ECTA7531> and of a simplified and a modified version of this model. The quadratic exponential model is suitable for the analysis of binary longitudinal data when state dependence (further to the effect of the covariates and a time-fixed individual intercept) has to be taken into account. Therefore, this is an alternative to the dynamic logit model having the advantage of easily allowing conditional inference in order to eliminate the individual intercepts and then getting consistent estimates of the parameters of main interest (for the covariates and the lagged response). The simplified version of this model does not distinguish, as the original model does, between the last time occasion and the previous occasions. The modified version formulates in a different way the interaction terms and it may be used to test in a easy way state dependence as shown in Bartolucci, F., Nigro, V. & Pigini, C. (2013, Econometric Reviews) <DOI:10.1080/07474938.2015.1060039>. The package also includes estimation of the dynamic logit model by a pseudo conditional estimator based on the quadratic exponential model, as proposed by Bartolucci, F. & Nigro, V. (2012, Journal of Econometrics) <DOI:10.1016/j.jeconom.2012.03.004>.

License GPL (>= 2)

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cquad-package

Conditional Maximum Likelihood for Quadratic Exponential Models for Binary Panel Data

Description

Estimation, based on conditional maximum likelihood, of the quadratic exponential model proposed by Bartolucci & Nigro (2010) and of a simplified and a modified version of this model. The quadratic exponential model is suitable for the analysis of binary longitudinal data when state dependence (further to the effect of the covariates and a time-fixed individual intercept) has to be taken into account. Therefore, this is an alternative to the dynamic logit model having the advantage of easily allowing conditional inference in order to eliminate the individual intercepts and then getting consistent estimates of the parameters of main interest (for the covariates and the lagged response). The simplified version of this model does not distinguish, as the original model does, between the last time occasion and the previous occasions. The modified version formulates in a different way the interaction terms and it may be used to test in an easy way state dependence as shown in Bartolucci, Nigro & Pigini (2013). The package also includes estimation of the dynamic logit model by a pseudo conditional estimator based on the quadratic exponential model, as proposed by Bartolucci & Nigro (2012).

Details

Package: cquad
Type: Package
Version: 1.4
Date: 2015-06-05
License: GPL (>= 2)
Author(s)
Francesco Bartolucci (University of Perugia, IT), Claudia Pigini (University of Perugia, IT)
Maintainer: Francesco Bartolucci <francesco.bartolucci@unipg.it>

References

Examples
```r
# example based on simulated data
data(data_sim)
data_sim = data_sim[1:500, ]  # to speed up the example, remove otherwise
# static model
out1 = cquad(y~X1+X2, data_sim, 100)
# dynamic model
out2 = cquad(y~X1+X2, data_sim, 100, dyn=TRUE)
```

cquad

*Interface for functions fitting different versions of cquad*

Description
Fit by conditional maximum likelihood each of the models in cquad package.

Usage
cquad(formula, data, index = NULL, model = c("basic","equal","extended","pseudo"),
       w = rep(1, n), dyn = FALSE)

Arguments

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>formula</td>
<td>formula with the same syntax as in plm package</td>
</tr>
<tr>
<td>data</td>
<td>data.frame or pdata.frame</td>
</tr>
<tr>
<td>index</td>
<td>to denote panel structure as in plm package</td>
</tr>
<tr>
<td>model</td>
<td>type of model = &quot;basic&quot;, &quot;equal&quot;, &quot;extended&quot;, &quot;pseudo&quot;</td>
</tr>
<tr>
<td>w</td>
<td>vector of weights (optional)</td>
</tr>
<tr>
<td>dyn</td>
<td>TRUE if in the dynamic version; FALSE for the static version (by default)</td>
</tr>
</tbody>
</table>
cquad_basic

Value

- **formula**: formula defining the model
- **lk**: conditional log-likelihood value
- **coefficients**: estimate of the regression parameters
- **vcov**: asymptotic variance-covariance matrix for the parameter estimates
- **scv**: matrix of individual scores
- **J**: Hessian of the log-likelihood function
- **se**: standard errors
- **ser**: robust standard errors
- **Tv**: number of time occasions for each unit

Author(s)

Francesco Bartolucci (University of Perugia), Claudia Pigini (University of Ancona "Politecnica delle Marche")

Examples

```r
C example based on simulated data
data(data_sim)
data_sim = data_sim[1:500,]  # to speed up the example, remove otherwise
# basic (static) model
out1 = cquad(y~X1+X2, data_sim, 100)
summary(out1)
# basic (dynamic) model
out2 = cquad(y~X1+X2, data_sim, 100, dyn=TRUE)
summary(out2)
# equal model
out3 = cquad(y~X1+X2, data_sim, 100, model="equal")
summary(out3)
# extended model
out4 = cquad(y~X1+X2, data_sim, 100, model="extended")
summary(out4)
# psuedo CML for dynamic model
out5 = cquad(y~X1+X2, data_sim, 100, model="pseudo")
summary(out5)
```

cquad_basic  

*Conditional maximum likelihood estimation of the basic quadratic exponential model*

Description

Fit by conditional maximum likelihood a simplified version of the model for binary longitudinal data proposed by Bartolucci & Nigro (2010); see also Cox (1972).
Usage

cquad_basic(id, yv, X = NULL, be = NULL, w = rep(1, n), dyn = FALSE)

Arguments

id list of the reference unit of each observation
yv corresponding vector of response variables
X corresponding matrix of covariates (optional)
be initial vector of parameters (optional)
w vector of weights (optional)
dyn TRUE if in the dynamic version; FALSE for the static version (by default)

Value

formula formula defining the model
lk conditional log-likelihood value
coefficients estimate of the regression parameters (including for the lag-response)
vcov asymptotic variance-covariance matrix for the parameter estimates
scv matrix of individual scores
J Hessian of the log-likelihood function
se standard errors
ser robust standard errors
Tv number of time occasions for each unit

Author(s)

Francesco Bartolucci (University of Perugia), Claudia Pigini (University of Ancona "Politecnica delle Marche")

References


Examples

# example based on simulated data
data(data_sim)
data_sim = data_sim[1:500,]  # to speed up the example, remove otherwise
id = data_sim$id; yv = data_sim$y; X = cbind(X1=data_sim$X1,X2=data_sim$X2)
# static model
out1 = cquad_basic(id,yv,X)
summary(out1)
# dynamic model
out2 = cquad_basic(id,yv,X,dyn=TRUE)
summary(out2)
**cquad_equ**

*Conditional maximum likelihood estimation for the modified version of the quadratic exponential model (to test for state dependence)*

---

**Description**

Fit by conditional maximum likelihood a modified version of the model for binary longitudinal data proposed by Bartolucci & Nigro (2010), in which the interaction terms have an extended form. This modified version is used to test for state dependence as described in Bartolucci et al. (2013).

**Usage**

```r
cquad_equ(id, yv, X = NULL, be = NULL, w = rep(1, n))
```

**Arguments**

- `id` : list of the reference unit of each observation
- `yv` : corresponding vector of response variables
- `X` : corresponding matrix of covariates (optional)
- `be` : initial vector of parameters (optional)
- `w` : vector of weights (optional)

**Value**

- `formula` : formula defining the model
- `lk` : conditional log-likelihood value
- `coefficients` : estimate of the regression parameters (including for the lag-response)
- `vcov` : asymptotic variance-covariance matrix for the parameter estimates
- `scv` : matrix of individual scores
- `J` : Hessian of the log-likelihood function
- `se` : standard errors
- `ser` : robust standard errors
- `Tv` : number of time occasions for each unit

**Author(s)**

Francesco Bartolucci (University of Perugia), Claudia Pigini (University of Perugia)

**References**


Examples

```r
# example based on simulated data
data(data_sim)
data_sim = data_sim[1:500,]  # to speed up the example, remove otherwise
id = data_sim$id; yv = data_sim$y; X = cbind(x1=data_sim$x1, x2=data_sim$x2)
# static model
out = cquad_equ(id, yv, X)
```

Descritption

Conditional maximum likelihood estimation of the quadratic exponential model for panel data

Usage

```r
cquad_ext(id, yv, X = NULL, be = NULL, w = rep(1, n))
```

Arguments

- `id`: list of the reference unit of each observation
- `yv`: corresponding vector of response variables
- `X`: corresponding matrix of covariates (optional)
- `be`: initial vector of parameters (optional)
- `w`: vector of weights (optional)

Value

- `formula`: formula defining the model
- `lk`: conditional log-likelihood value
- `coefficients`: estimate of the regression parameters (including for the lag-response)
- `vcov`: asymptotic variance-covariance matrix for the parameter estimates
- `scv`: matrix of individual scores
- `J`: Hessian of the log-likelihood function
- `se`: standard errors
- `ser`: robust standard errors
- `Tv`: number of time occasions for each unit

Author(s)

Francesco Bartolucci (University of Perugia), Claudia Pigini (University of Ancona "Politecnica delle Marche")
References


Examples

```r
# example based on simulated data
data(data_sim)
data_sim = data_sim[1:500,]  # to speed up the example, remove otherwise
id = data_sim$id; yv = data_sim$y; X = cbind(X1=data_sim$data_X1, X2=data_sim$data_X2)
# static model
out = cquad_ext(id,yv,X)
summary(out)
```

---

cquad_pseudo

**Pseudo conditional maximum likelihood estimation of the dynamic logit model**

Description

Estimate the dynamic logit model for binary longitudinal data by the pseudo conditional maximum likelihood method proposed by Bartolucci & Nigro (2012).

Usage

cquad_pseudo(id, yv, X = NULL, be = NULL)

Arguments

- **id**: list of the reference unit of each observation
- **yv**: corresponding vector of response variables
- **X**: corresponding matrix of covariates (optional)
- **be**: initial vector of parameters (optional)

Value

- **formula**: formula defining the model
- **lk**: conditional log-likelihood value
- **coefficients**: estimate of the regression parameters (including for the lag-response)
- **vcov**: asymptotic variance-covariance matrix for the parameter estimates
- **scv**: matrix of individual scores
- **J**: Hessian of the log-likelihood function
- **se**: standard errors
- **se2**: robust standard errors that also take into account the first step
- **Tv**: number of time occasions for each unit
data_sim

Author(s)
Francesco Bartolucci (University of Perugia), Claudia Pigini (University of Ancona "Politecnica delle Marche")

References

Examples
```r
## Not run:
# example based on simulated data
data(data_sim)
data_sim = data_sim[1:500,]  # to speed up the example, remove otherwise
id = data_sim$id; yv = data_sim$y; X = cbind(X1=data_sim$X1,X2=data_sim$X2)
# estimate dynamic logit model
out = cquad_pseudo(id,yv,X)
summary(out)

## End(Not run)
```

---

data_sim  Simulated dataset

Description
It contains a dataset simulated from the dynamic logit model

Usage
data(data_sim)

Format
The observations are for 1000 sample units at 5 five time occasions:

id  list of the reference unit of each observation
time  number of the time occasion
X1  first covariate
X2  second covariate
y  response

Examples
data(data_sim)
head(data_sim)
print.cquad  

Print output for class cquad

Description
Print output for class cquad and output provided by cquad_basic, cquad_equ, cquad_ext, cquad_pseudo

Usage

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

Arguments

- **x**: output of class cquad
- **...**: further arguments passed to or from other methods

Author(s)

Francesco Bartolucci (University of Perugia), Claudia Pigini (University of Ancona "Politecnica delle Marche")

sim_panel_logit  

Simulate data from the dynamic logit model

Description
Simulate data from the dynamic logit model given a set of covariates and a vector of parameters.

Usage

```
sim_panel_logit(id, al, X = NULL, eta, dyn = FALSE)
```

Arguments

- **id**: list of the reference unit of each observation
- **al**: list of individual specific effects
- **X**: corresponding matrix of covariates (optional)
- **eta**: vector of parameters
- **dyn**: TRUE if in the dynamic version; FALSE for the static version (by default)

Value

- **yv**: simulated vector of binary response variables
- **pv**: vector of probabilities of "success"
**Author(s)**

Francesco Bartolucci (University of Perugia), Claudia Pigini (University of Ancona "Politecnica delle Marche")

**Examples**

```r
# simulate data from the static logit model
n = 1000; TT = 5          # sample size, number of time occasions
id = (1:n) %*% rep(1,TT)  # vector of indices
al = rnorm(n)            # simulate alpha
X = matrix(rnorm(2*n*TT),n*TT,2) # simulate two covariates
eta1 = c(1,-1)           # vector of parameters
out = sim_panel_logit(id,al,X,eta1)
y1 = out$yv

# simulate data from the dynamic logit model
eta2 = c(1,-1,2)         # vector of parameters including state dependence
out = sim_panel_logit(id,al,X,eta2,dyn=TRUE)
y2 = out$yv
```

---

**sq**

*Generate binary sequences*

**Description**

Generate binary sequences of a certain length and with a certain sum.

**Usage**

```r
sq(J, s = NULL)
```

**Arguments**

- `J` length of the binary sequences
- `s` sum of the binary sequences (optional)

**Value**

- `M` Matrix of binary configurations

**Author(s)**

Francesco Bartolucci (University of Perugia)

**Examples**

```r
# generate all sequence of 5 binary variables
sq(5)
# generate all sequence of 5 binary variables, with sum equal 2
sq(5,2)
```
**summary.cquad**

---

**summary.cquad**  
**Summary for class cquad**

---

**Description**

Summarize the output for class cquad provided by cquad_basic, cquad_equ, cquad_ext, cquad_pseudo.

**Usage**

```r
## S3 method for class 'cquad'
summary(object, ...)
```

**Arguments**

- `object`: output of class cquad
- `...`: further arguments passed to or from other methods

**Author(s)**

Francesco Bartolucci (University of Perugia), Claudia Pigini (University of Ancona "Politecnica delle Marche")
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