Package ‘saeHB.ME’

August 21, 2023

Type Package
Title Small Area Estimation with Measurement Error using Hierarchical Bayesian Method
Version 1.0.1
License GPL-3
Encoding UTF-8
LazyData true
Imports coda, rjags, stringr
Depends R (>= 4.1)
RoxygenNote 7.2.3
NeedsCompilation no
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Repository CRAN
Date/Publication 2023-08-21 04:00:02 UTC

R topics documented:
saeHB.ME-package ............................................. 2
dataHBME .......................................................... 3
dataTMEHB .......................................................... 4
meHBNormal ....................................................... 5
meHBt ............................................................... 6

Index 9
saeHB.ME-package

**saeHB.ME: Small Area Estimation with Measurement Error using Hierarchical Bayesian Method**

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**Description**

Implementation of small area estimation using Hierarchical Bayesian (HB) Method when auxiliary variable measured with error. The ‘rjags’ package is employed to obtain parameter estimates.

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**Functions**

- **meHBNormal**: Produces HB estimators, standard error, random effect variance, coefficient and plot under normal distribution.
- **meHBT**: Produces HB estimators, standard error, random effect variance, coefficient and plot under student-t distribution.

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**References**


Description

This data generated by simulation based on Hierarchical Bayesian Method under Normal Distribution with Measurement Error by following these steps:

1. Generate $x_1 \sim \text{UNIF}(0, 1)$, $x_2 \sim \text{UNIF}(1,5)$, $x_3 \sim \text{UNIF}(10,15)$, and $x_4 \sim \text{UNIF}(10,20)$
2. Generate $v.x_1 \sim \text{Gamma}(1,1)$ and $v.x_2 \sim \text{Gamma}(2,1)$
3. Generate $x_{1h} \sim N(x_1, \sqrt{v.x_1})$ and $x_{2h} \sim N(x_2, \sqrt{v.x_2})$
4. Generate $\beta_0, \beta_1, \beta_2, \beta_3$, and $\beta_4$
5. Generate $u \sim N(0,1)$ and $v \sim 1/(\text{Gamma}(1,1))$
6. Calculate $\mu = \beta_0 + \beta_1 * x_{1h} + \beta_2 * x_{2h} + \beta_3 * x_3 + \beta_4 * x_4 + u$
7. Generate $Y \sim N(\mu, \sqrt{v})$

Direct estimation $Y$, auxiliary variables $x_1 \times x_2 \times x_3 \times x_4$, sampling variance $v$, and mean squared error of auxiliary variables $v.x_1$ and $v.x_2$ are arranged in a dataframe called dataHBME.

Usage

data(dataHBME)

Format

A data frame with 30 observations on the following 8 variables.

$Y$ direct estimation of $Y$.
$x_1$ auxiliary variable of $x_1$.
$x_2$ auxiliary variable of $x_2$.
$x_3$ auxiliary variable of $x_3$.
$x_4$ auxiliary variable of $x_4$.
vardir sampling variances of $Y$.
$v.x_1$ mean squared error of $x_1$.
$v.x_2$ mean squared error of $x_2$.
Description

This data generated by simulation based on Hierarchical Bayesian Method under Student-t Distribution with Measurement Error by following these steps:

1. Generate $x_1 \sim \text{UNIF}(10, 20)$ and $x_2 \sim \text{UNIF}(30,50)$
2. Generate $v.x_1 \sim 1/(	ext{Gamma}(1,1))$
3. Generate $x_{1h} \sim \text{N}(x_1)$
4. Generate $\beta_0 = \beta_1 = \beta_2 = 0.5$
5. Generate $u \sim \text{N}(0,1)$ and $k \sim \text{Gamma}(10,1)$
6. Calculate $\mu = \beta_0 + \beta_1 \times x_{1h} + \beta_2 \times x_{2h} + u$
7. Generate $Y \sim t(k, \mu)$ and $v = \sigma_y^2$

Direct estimation $Y$, auxiliary variables $x_1 \ x_2 \ x_3 \ x_4$, sampling variance $v$, and mean squared error of auxiliary variables $v.x_1 \ v.x_2$ are arranged in a dataframe called dataTMEHB.

Usage

data(dataTMEHB)

Format

A data frame with 30 observations on the following 8 variables.

$Y$ direct estimation of $Y$.

$x_1$ auxiliary variable of $x_1$.

$x_2$ auxiliary variable of $x_2$.

$vardir$ sampling variances of $Y$.

$v.x_1$ mean squared error of $x_1$. 
meHBNormal

Small Area Estimation with Measurement Error using Hierarchical Bayesian Method under Normal Distribution

Description

This function is implemented to variable of interest (y) that assumed to be a Normal Distribution when auxiliary variable is measured with error.

Usage

meHBNormal(
  formula,
  vardir,
  var.x,
  coef,
  var.coef,
  iter.update = 3,
  iter.mcmc = 10000,
  thin = 2,
  tau.u = 1,
  burn.in = 2000,
  data
)

Arguments

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>formula</td>
<td>an object of class formula (or one that can be coerced to that class): a symbolic description of the model to be fitted. The variables included formula must have a length equal to the number of domains m. This formula can provide auxiliary variable either measured with error or combination between measured with error and without error. If the auxiliary variable are combination between error and without error, input the error variable first followed by without error variable.</td>
</tr>
<tr>
<td>vardir</td>
<td>vector containing the m sampling variances of direct estimators for each domain. The values must be sorted as the Y.</td>
</tr>
<tr>
<td>var.x</td>
<td>vector containing mean squared error of X. The values must be sorted as the X.</td>
</tr>
<tr>
<td>coef</td>
<td>a vector contains prior initial value of Coefficient of Regression Model for fixed effect with default vector of 0 with the length of the number of regression coefficients.</td>
</tr>
<tr>
<td>var.coef</td>
<td>a vector contains prior initial value of variance of Coefficient of Regression Model with default vector of 1 with the length of the number of regression coefficients.</td>
</tr>
<tr>
<td>iter.update</td>
<td>number of updates with default 3.</td>
</tr>
<tr>
<td>iter.mcmc</td>
<td>number of total iterations per chain with default 10000.</td>
</tr>
</tbody>
</table>
thin: thinning rate, must be a positive integer with default 2.

tau.u: prior initial value of inverse of Variance of area random effect with default 1.

burn.in: number of iterations to discard at the beginning with default 2000.

data: the data frame.

Value

This function returns a list with the following objects:

- **Est**: A vector with the values of Small Area mean Estimates using Hierarchical bayesian method
- **refVar**: Estimated random effect variances
- **coefficient**: A data frame with the estimated model coefficient
- **plot**: Trace, Dencity, Autocorrelation Function Plot of MCMC samples

Examples

```r
## Load dataset
data(dataHBME)

## Auxiliary variables only contains variable with error
text <- meHBNormal(Y~x1+x2, vardir = "vardir",
                   var.x = c("v.x1","v.x2"), iter.update = 3, iter.mcmc = 10000,
                   thin = 5, burn.in = 1000, data = dataHBME)

## Auxiliary variables contains variable with error and without error
text_mix <- meHBNormal(Y~x1+x2+x3, vardir = "vardir",
                     var.x = c("v.x1","v.x2"), iter.update = 3, iter.mcmc = 10000,
                     thin = 5, burn.in = 1000, data = dataHBME)

## Create dataset with nonsampled area
dataHBMEens <- dataHBME
dataHBMEens[c(1,10,20,30),"Y"] <- NA

## For data with nonsampled area use dataHBMEens
```

Description

This function is implemented to variable of interest (y) that assumed to be a Normal Distribution when auxiliary variable is measured with error.
meHBt

Usage

meHBt(
  formula,
  vardir,
  var.x,
  coef,
  var.coef,
  iter.update = 3,
  iter.mcmc = 10000,
  thin = 2,
  tau.u = 1,
  burn.in = 2000,
  data
)

Arguments

formula an object of class formula (or one that can be coerced to that class): a symbolic description of the model to be fitted. The variables included formula must have a length equal to the number of domains m. This formula can provide auxiliary variable either measured with error or combination between measured with error and without error. If the auxiliary variable are combination between error and without error, input the error variable first followed by without error variable.

vardir vector containing the m sampling variances of direct estimators for each domain. The values must be sorted as the Y.

var.x vector containing mean squared error of X. The values must be sorted as the X.

coef a vector contains prior initial value of Coefficient of Regression Model for fixed effect with default vector of 0 with the length of the number of regression coefficients.

var.coef a vector contains prior initial value of variance of Coefficient of Regression Model with default vector of 1 with the length of the number of regression coefficients.

iter.update number of updates with default 3.

iter.mcmc number of total iterations per chain with default 10000.

thin thinning rate, must be a positive integer with default 2.

tau.u prior initial value of inverse of Variance of area random effect with default 1.

burn.in number of iterations to discard at the beginning with default 2000.

data the data frame.

Value

This function returns a list with the following objects:

Est A vector with the values of Small Area mean Estimates using Hierarchical bayesian method
refVar Estimated random effect variances
coefficient A data frame with the estimated model coefficient
plot Trace, Dencity, Autocorrelation Function Plot of MCMC samples

Examples

```r
## Load dataset
data(dataTMEHB)

## Auxiliary variables only contains variable with error
extuple <- meHBt(Y~x1, vardir = "vardir",
    var.x = c("v.x1"), iter.update = 3, iter.mcmc = 10000,
    thin = 5, burn.in = 1000, data = dataTMEHB)

## Auxiliary variables contains variable with error and without error
extuple_mix <- meHBt(Y~x1+x2, vardir = "vardir",
    var.x = c("v.x1"), iter.update = 3, iter.mcmc = 10000,
    thin = 5, burn.in = 1000, data = dataTMEHB)

## Create dataset with nonsampled area
dataTMEHBns <- dataTMEHB
dataTMEHBns[c(1,10,20,30),"Y"] <- NA

## For data with nonsampled area use dataTMEHBns
```
Index

dataHBME, 3
dataTMEHB, 4

formula, 5, 7

meHBNormal, 2, 5
meHBt, 2, 6

saeHB.ME (saeHB.ME-package), 2
saeHB.ME-package, 2