

# Package ‘zic’

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**Title** Bayesian Inference for Zero-Inflated Count Models

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**Description** Provides MCMC algorithms for the analysis of zero-inflated count models. The case of stochastic search variable selection (SVS) is also considered. All MCMC samplers are coded in C++ for improved efficiency. A data set considering the demand for health care is provided.

**License** GPL (>= 2)

**Depends** R (>= 3.0.2)

**Imports** Rcpp (>= 0.11.0), coda (>= 0.14-2)

**LinkingTo** Rcpp, RcppArmadillo

**NeedsCompilation** yes

**Repository** CRAN

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 docvisits

*Demand for Health Care Data*


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### Description

This data set gives the number of doctor visits in the last three months for a sample of German male individuals in 1994. The data set is taken from Riphahn et al. (2003) and is a subsample of the German Socioeconomic Panel (SOEP). In contrast to Riphahn et al. (2003) only male individuals from the last wave are considered. See Jochmann (2013) for further details.

### Usage

```
data(docvisits)
```

### Format

This data frame contains 1812 observations on the following 22 variables:

**docvisits** number of doctor visits in last 3 months

**age** age

**agesq** age squared / 1000

**age30** 1 if age  $\geq$  30

**age35** 1 if age  $\geq$  35

**age40** 1 if age  $\geq$  40

**age45** 1 if age  $\geq$  45

**age50** 1 if age  $\geq$  50

**age55** 1 if age  $\geq$  55

**age60** 1 if age  $\geq$  60

**health** health satisfaction, 0 (low) - 10 (high)

**handicap** 1 if handicapped, 0 otherwise

**hdegree** degree of handicap in percentage points

**married** 1 if married, 0 otherwise

**schooling** years of schooling

**hhincome** household monthly net income, in German marks / 1000

**children** 1 if children under 16 in the household, 0 otherwise

**self** 1 if self employed, 0 otherwise

**civil** 1 if civil servant, 0 otherwise

**bluec** 1 if blue collar employee, 0 otherwise

**employed** 1 if employed, 0 otherwise

**public** 1 if public health insurance, 0 otherwise

**addon** 1 if add-on insurance, 0 otherwise

## References

- Jochmann, M. (2013). “What Belongs Where? Variable Selection for Zero-Inflated Count Models with an Application to the Demand for Health Care”, *Computational Statistics*, 28, 1947–1964.
- Riphahn, R. T., Wambach, A., Million, A. (2003). “Incentive Effects in the Demand for Health Care: A Bivariate Panel Count Data Estimation”, *Journal of Applied Econometrics*, 18, 387–405.
- Wagner, G. G., Frick, J. R., Schupp, J. (2007). “The German Socio-Economic Panel Study (SOEP) – Scope, Evolution and Enhancements”, *Schmollers Jahrbuch*, 127, 139–169.

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zic

*Bayesian Inference for Zero-Inflated Count Models*


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## Description

zic fits zero-inflated count models via Markov chain Monte Carlo methods.

## Usage

```
zic(formula, data, a0, b0, c0, d0, e0, f0,
    n.burnin, n.mcmc, n.thin, tune = 1.0, scale = TRUE)
```

## Arguments

formula	A symbolic description of the model to be fit specifying the response variable and covariates.
data	A data frame in which to interpret the variables in formula.
a0	The prior variance of $\alpha$ .
b0	The prior variance of $\beta_j$ .
c0	The prior variance of $\gamma$ .
d0	The prior variance of $\delta_j$ .
e0	The shape parameter for the inverse gamma prior on $\sigma^2$ .
f0	The inverse scale parameter the inverse gamma prior on $\sigma^2$ .
n.burnin	Number of burn-in iterations of the sampler.
n.mcmc	Number of iterations of the sampler.
n.thin	Thinning interval.
tune	Tuning parameter of Metropolis-Hastings step.
scale	If true, all covariates (except binary variables) are rescaled by dividing by their respective standard errors.

## Details

The considered zero-inflated count model is given by

$$\begin{aligned} y_i^* &\sim \text{Poisson}[\exp(\eta_i^*)], \\ \eta_i^* &= \alpha + x_i' \beta + \varepsilon_i, \quad \varepsilon_i \sim N(0, \sigma^2), \\ d_i^* &= \gamma + x_i' \delta + \nu_i, \quad \nu_i \sim N(0, 1), \\ y_i &= 1(d_i^* > 0) y_i^*, \end{aligned}$$

where  $y_i$  and  $x_i$  are observed. The assumed prior distributions are

$$\begin{aligned} \alpha &\sim N(0, a_0), \\ \beta_k &\sim N(0, b_0), \quad k = 1, \dots, K, \\ \gamma &\sim N(0, c_0), \\ \delta_k &\sim N(0, d_0), \quad k = 1, \dots, K, \\ \sigma^2 &\sim \text{Inv-Gamma}(e_0, f_0). \end{aligned}$$

The sampling algorithm described in Jochmann (2013) is used.

## Value

A list containing the following elements:

alpha	Posterior draws of $\alpha$ (coda mcmc object).
beta	Posterior draws of $\beta$ (coda mcmc object).
gamma	Posterior draws of $\gamma$ (coda mcmc object).
delta	Posterior draws of $\delta$ (coda mcmc object).
sigma2	Posterior draws of $\sigma^2$ (coda mcmc object).
acc	Acceptance rate of the Metropolis-Hastings step.

## References

Jochmann, M. (2013). “What Belongs Where? Variable Selection for Zero-Inflated Count Models with an Application to the Demand for Health Care”, *Computational Statistics*, 28, 1947–1964.

## Examples

```
## Not run:
data( docvisits )
mdl <- docvisits ~ age + agesq + health + handicap + hdegree + married + schooling +
             hhincome + children + self + civil + bluec + employed + public + addon
post <- zic( f, docvisits, 10.0, 10.0, 10.0, 10.0, 1.0, 1.0, 1000, 10000, 10, 1.0, TRUE )
## End(Not run)
```

zic.svs

*SVS for Zero-Inflated Count Models***Description**

zic.svs applies SVS to zero-inflated count models

**Usage**

```
zic.svs(formula, data,
        a0, g0.beta, h0.beta, nu0.beta, r0.beta, s0.beta, e0, f0,
        c0, g0.delta, h0.delta, nu0.delta, r0.delta, s0.delta,
        n.burnin, n.mcmc, n.thin, tune = 1.0, scale = TRUE)
```

**Arguments**

formula	A symbolic description of the model to be fit specifying the response variable and covariates.
data	A data frame in which to interpret the variables in formula.
a0	The prior variance of $\alpha$ .
g0.beta	The shape parameter for the inverse gamma prior on $\kappa_k^\beta$ .
h0.beta	The inverse scale parameter for the inverse gamma prior on $\kappa_k^\beta$ .
nu0.beta	Prior parameter for the spike of the hypervariances for the $\beta_k$ .
r0.beta	Prior parameter of $\omega^\beta$ .
s0.beta	Prior parameter of $\omega^\beta$ .
e0	The shape parameter for the inverse gamma prior on $\sigma^2$ .
f0	The inverse scale parameter the inverse gamma prior on $\sigma^2$ .
c0	The prior variance of $\gamma$ .
g0.delta	The shape parameter for the inverse gamma prior on $\kappa_k^\delta$ .
h0.delta	The inverse scale parameter for the inverse gamma prior on $\kappa_k^\delta$ .
nu0.delta	Prior parameter for the spike of the hypervariances for the $\delta_k$ .
r0.delta	Prior parameter of $\omega^\delta$ .
s0.delta	Prior parameter of $\omega^\delta$ .
n.burnin	Number of burn-in iterations of the sampler.
n.mcmc	Number of iterations of the sampler.
n.thin	Thinning interval.
tune	Tuning parameter of Metropolis-Hastings step.
scale	If true, all covariates (except binary variables) are rescaled by dividing by their respective standard errors.

## Details

The considered zero-inflated count model is given by

$$\begin{aligned} y_i^* &\sim \text{Poisson}[\exp(\eta_i^*)], \\ \eta_i^* &= \alpha + x_i' \beta + \varepsilon_i, \quad \varepsilon_i \sim \text{N}(0, \sigma^2), \\ d_i^* &= \gamma + x_i' \delta + \nu_i, \quad \nu_i \sim \text{N}(0, 1), \\ y_i &= 1(d_i^* > 0) y_i^*, \end{aligned}$$

where  $y_i$  and  $x_i$  are observed. The assumed prior distributions are

$$\begin{aligned} \alpha &\sim \text{N}(0, a_0), \\ \beta_k &\sim \text{N}(0, \tau_k^\beta \kappa_k^\beta), \quad k = 1, \dots, K, \\ \kappa_j^\beta &\sim \text{Inv-Gamma}(g_0^\beta, h_0^\beta), \\ \tau_k^\beta &\sim (1 - \omega^\beta) \delta_{\nu_0^\beta} + \omega^\beta \delta_1, \\ \omega^\beta &\sim \text{Beta}(r_0^\beta, s_0^\beta), \\ \gamma &\sim \text{N}(0, c_0), \\ \delta_k &\sim \text{N}(0, \tau_k^\delta \kappa_k^\delta), \quad k = 1, \dots, K, \\ \kappa_k^\delta &\sim \text{Inv-Gamma}(g_0^\delta, h_0^\delta), \\ \tau_k^\delta &\sim (1 - \omega^\delta) \delta_{\nu_0^\delta} + \omega^\delta \delta_1, \\ \omega^\delta &\sim \text{Beta}(r_0^\delta, s_0^\delta), \\ \sigma^2 &\sim \text{Inv-Gamma}(e_0, f_0). \end{aligned}$$

The sampling algorithm described in Jochmann (2013) is used.

## Value

A list containing the following elements:

alpha	Posterior draws of $\alpha$ (coda mcmc object).
beta	Posterior draws of $\beta$ (coda mcmc object).
gamma	Posterior draws of $\gamma$ (coda mcmc object).
delta	Posterior draws of $\delta$ (coda mcmc object).
sigma2	Posterior draws of $\sigma^2$ (coda mcmc object).
I.beta	Posterior draws of indicator whether $\tau_j^\beta$ is one (coda mcmc object).
I.delta	Posterior draws of indicator whether $\tau_j^\delta$ is one (coda mcmc object).
omega.beta	Posterior draws of $\omega^\beta$ (coda mcmc object).
omega.delta	Posterior draws of $\omega^\delta$ (coda mcmc object).
acc	Acceptance rate of the Metropolis-Hastings step.

## References

Jochmann, M. (2013). “What Belongs Where? Variable Selection for Zero-Inflated Count Models with an Application to the Demand for Health Care”, *Computational Statistics*, 28, 1947–1964.

## Examples

```
## Not run:
data( docvisits )
mdl <- docvisits ~ age + agesq + health + handicap + hdegree + married + schooling +
  hhincome + children + self + civil + bluec + employed + public + addon
post <- zic.ssvs( mdl, docvisits,
  10.0, 5.0, 5.0, 1.0e-04, 2.0, 2.0, 1.0, 1.0,
  10.0, 5.0, 5.0, 1.0e-04, 2.0, 2.0,
  1000, 10000, 10, 1.0, TRUE )
## End(Not run)
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