

# Package ‘ZIM’

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**Title** Zero-Inflated Models (ZIM) for Count Time Series with Excess Zeros

**Version** 1.1.0

**Description** Analyze count time series with excess zeros.

Two types of statistical models are supported: Markov regression by Yang et al. (2013) <[doi:10.1016/j.stamet.2013.02.001](https://doi.org/10.1016/j.stamet.2013.02.001)> and state-space models by Yang et al. (2015) <[doi:10.1177/1471082X14535530](https://doi.org/10.1177/1471082X14535530)>. They are also known as observation-driven and parameter-driven models respectively in the time series literature. The functions used for Markov regression or observation-driven models can also be used to fit ordinary regression models with independent data under the zero-inflated Poisson (ZIP) or zero-inflated negative binomial (ZINB) assumption. Besides, the package contains some miscellaneous functions to compute density, distribution, quantile, and generate random numbers from ZIP and ZINB distributions.

**License** GPL-3

**Encoding** UTF-8

**RoxygenNote** 6.1.0

**Imports** MASS

**Suggests** pscl, TSA

**URL** <https://github.com/biostatstudio/ZIM>

**BugReports** <https://github.com/biostatstudio/ZIM/issues>

**NeedsCompilation** no

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ZIM-package

*Zero-Inflated Models for Count Time Series with Excess Zeros*

---

### Description

Fits observation-driven and parameter-driven models for count time series with excess zeros.

### Details

The package ZIM contains functions to fit statistical models for count time series with excess zeros (Yang et al., 2013, 2015). The main function for fitting observation-driven models is `zim`, and the main function for fitting parameter-driven models is `dzim`.

### Note

The observation-driven models for zero-inflated count time series can also be fit using the function `zeroinfl` from the `pscl` package (Zeileis et al., 2008). Fitting parameter-driven models is based on sequential Monte Carlo (SMC) methods, which are computer intensive and could take several hours to estimate the model parameters.

## References

Yang, M., Cavanaugh, J. E., and Zamba, G. K. D. (2015). State-space models for count time series with excess zeros. *Statistical Modelling*, **15**:70-90

Yang, M., Zamba, G. K. D., and Cavanaugh, J. E. (2013). Markov regression models for count time series with excess zeros: A partial likelihood approach. *Statistical Methodology*, **14**:26-38.

Zeileis, A., Kleiber, C., and Jackman, S. (2008). Regression models for count data in R. *Journal of Statistical Software*, **27**(8).

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bshift	<i>Backshift Operator</i>
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## Description

Apply the backshift operator or lag operator to a time series objective.

## Usage

```
bshift(x, k = 1)
```

## Arguments

x	univariate or multivariate time series.
k	number of lags.

## See Also

[lag](#), [zlag](#)

## Examples

```
x <- arima.sim(model = list(ar = 0.8, sd = 0.5), n = 120)
bshift(x, k = 12)
```

---

dzim *Fitting Dynamic Zero-Inflated Models*

---

### Description

dzim is used to fit dynamic zero-inflated models.

### Usage

```
dzim(formula, data, subset, na.action, weights = 1, offset = 0,
      control = dzim.control(...), ...)
```

### Arguments

formula	an objective of class "formula".
data	an optional dataframe, list or environment containing the variables in the model.
subset	an optional vector specifying a subset of observations to be used in the fitting process.
na.action	a function which indicates what should happen when the data contain NAs.
weights	an optional vector of 'prior weights' to be used in the fitting process.
offset	this can be used to specify a priori known component to be included in the linear predictor during fitting.
control	control arguments from <a href="#">dzim.control</a>
...	additional arguments

### See Also

[dzim.fit](#), [dzim.filter](#), [dzim.smooth](#), [dzim.control](#), [dzim.sim](#), [dzim.plot](#)

---

dzim.control *Auxiliary for Controlling DZIM Fitting*

---

### Description

Auxiliary function for [dzim](#) fitting. Typically only used internally by [dzim.fit](#), but may be used to construct a control argument for either function.

### Usage

```
dzim.control(dist = c("poisson", "nb", "zip", "zinb"), trace = FALSE,
             start = NULL, order = 1, mu0 = rep(0, order), Sigma0 = diag(1,
             order), N = 1000, R = 1000, niter = 500)
```

**Arguments**

dist	count model family
trace	logical; if TRUE, display iteration history.
start	initial parameter values.
order	autoregressive order.
mu0	mean vector for initial state.
Sigma0	covariance matrix for initial state.
N	number of particles in particle filtering.
R	number of replications in particle smoothing.
niter	number of iterations.

**Note**

The default values of N, R, and niter are chosen based on our experience. In some cases, N = 500, R = 500, and niter = 200 might be sufficient. The `dzim.plot` function should always be used for convergence diagnostics.

**See Also**

[dzim](#), [dzim.fit](#), [dzim.filter](#), [dzim.smooth](#), [dzim.sim](#), [dzim.plot](#)

---

dzim.filter

*Particle Filtering for DZIM*

---

**Description**

Function to implement the particle filtering method proposed by Gordsill et al. (1993).

**Usage**

```
dzim.filter(y, X, w, para, control)
```

**Arguments**

y	response variable.
X	design matrix.
w	$\log(w)$ is used as an offset variable in the linear predictor.
para	model parameters.
control	control arguments.

**References**

Gordon, N. J., Salmond, D. J., and Smith, A. F. M. (1993). Novel approach to nonlinear/non-Gaussian Bayesian state estimation. *IEEE Proceedings*, **140**, 107-113.

**See Also**

[dzim](#), [dzim.fit](#), [dzim.smooth](#), [dzim.control](#), [dzim.sim](#), [dzim.plot](#)

---

dzim.fit

*Fitter Function for Dynamic Zero-Inflated Models*

---

**Description**

[dzim.fit](#) is the basic computing engine called by [dzim](#) used to fit dynamic zero-inflated models. This should usually *not* be used directly unless by experienced users.

**Usage**

```
dzim.fit(y, X, offset = rep(0, n), control = dzim.control(...), ...)
```

**Arguments**

y	response variable.
X	design matrix.
offset	offset variable.
control	control arguments.
...	additional arguments.

**See Also**

[dzim](#), [dzim.control](#), [dzim.filter](#), [dzim.smooth](#), [dzim.sim](#), [dzim.plot](#)

---

dzim.plot

*Trace Plots from DZIM*

---

**Description**

Function to display trace plots from a dynamic zero-inflated model.

**Usage**

```
dzim.plot(object, k.inv = FALSE, sigma.sq = FALSE, ...)
```

**Arguments**

object	objective from <a href="#">dzim</a> or <a href="#">dzim.fit</a> .
k.inv	logical; indicating whether an inverse transformation is needed for the dispersion parameter.
sigma.sq	logical; indicating whether a square transformation is needed for the standard deviation parameter.
...	additional arguments.

dzim.sim

*Simulate Data from DZIM***Description**

Simulate data from a dynamic zero-inflated model.

**Usage**

```
dzim.sim(X, w, omega, k, beta, phi, sigma, mu0, Sigma0)
```

**Arguments**

X	design matrix.
w	$\log(w)$ is used as an offset variable in the linear predictor.
omega	zero-inflation parameter.
k	dispersion parameter.
beta	regression coefficients.
phi	autoregressive coefficients.
sigma	standard deviation.
mu0	mean vector of initial state.
Sigma0	covariance matrix of initial state.

**See Also**

[dzim](#), [dzim.fit](#), [dzim.filter](#), [dzim.smooth](#), [dzim.control](#), [dzim.plot](#)

dzim.smooth

*Particle Smoothing for DZIM***Description**

Function to implement the particle smoothing method proposed by Gordsill et al. (2004).

**Usage**

```
dzim.smooth(y, X, w, para, control)
```

**Arguments**

y	response variable.
X	design matrix.
w	$\log(w)$ is used as an offset variable in the linear predictor.
para	model parameters.
control	control arguments.

**References**

Gordsill, S. J., Doucet, A., and West, M. (2004). Monte Carlo smoothing for nonlinear time series. *Journal of the American Statistical Association*, **99**, 156-168.

**See Also**

[dzim](#), [dzim.fit](#), [dzim.filter](#), [dzim.control](#), [dzim.sim](#), [dzim.plot](#)

injury

*Example: Injury Series from Occupational Health*

**Description**

Monthly number of injuries in hospitals from July 1988 to October 1995.

**Source**

Numbers from Figure 1 of Yau et al. (2004).

**References**

Yau, K. K. W., Lee, A. H. and Carrivick, P. J. W. (2004). Modeling zero-inflated count series with application to occupational health. *Computer Methods and Programs in Biomedicine*, **74**, 47-52.

**Examples**

```
data(injury)
plot(injury, type = "o", pch = 20, xaxt = "n", yaxt = "n", ylab = "Injury Count")
  axis(side = 1, at = seq(1, 96, 8))
  axis(side = 2, at = 0:9)
  abline(v = 57, lty = 2)
  mtext("Pre-intervention", line = 1, at = 25, cex = 1.5)
  mtext("Post-intervention", line = 1, at = 80, cex = 1.5)
```

pvalue

*Function to Compute P-value.*

**Description**

Function to compute p-value based on a t-statistic.

**Usage**

```
pvalue(t, df = Inf, alternative = c("two.sided", "less", "greater"))
```

**Arguments**

t	t-statistic.
df	degree of freedoms.
alternative	type of alternatives.

**Examples**

```
pvalue(1.96, alternative = "greater")
```

---

syph

*Example: Syphilis Series*


---

**Description**

Weekly number of syphilis cases in the United States from 2007 to 2010.

**Format**

A data frame with 209 observations on the following 69 variables.

year	Year
week	Week
a1	<b>United States</b>
a2	<b>New England</b>
a3	Connecticut
a4	Maine
a5	Massachusetts
a6	New Hampshire
a7	Rhode Island
a8	Vermont
a9	<b>Mid. Atlantic</b>
a10	New Jersey
a11	New York (Upstate)
a12	New York City
a13	Pennsylvania
a14	<b>E.N. Central</b>
a15	Illinois
a16	Indiana
a17	Michigan
a18	Ohio
a19	Wisconsin
a20	<b>W.N. Central</b>
a21	Iowa
a22	Kansas
a23	Minnesota
a24	Missouri

a25 Nebraska  
a26 North Dakota  
a27 South Dakota  
a28 **S. Atlantic**  
a29 Delaware  
a30 District of Columbia  
a31 Florida  
a32 Georgia  
a33 Maryland  
a34 North Carolina  
a35 South Carolina  
a36 Virginia  
a37 West Virginia  
a38 **E.S. Central**  
a39 Alabama  
a40 Kentucky  
a41 Mississippi  
a42 Tennessee  
a43 **W.S. Central**  
a44 Arkansas  
a45 Louisiana  
a46 Oklahoma  
a47 Texas  
a48 **Mountain**  
a49 Arizona  
a50 Colorado  
a51 Idaho  
a52 Montana  
a53 Nevada  
a54 New Mexico  
a55 Utah  
a56 Wyoming  
a57 **Pacific**  
a58 Alaska  
a59 California  
a60 Hawaii  
a61 Oregon  
a62 Washington  
a63 American Samoa  
a64 C.N.M.I.  
a65 Guam  
a66 Puerto Rico  
a67 U.S. Virgin Islands

**Note**

C.N.M.I.: Commonwealth of Northern Mariana Islands.

**Source**

CDC Morbidity and Mortality Weekly Report (<http://www.cdc.gov/MMWR/>).

**Examples**

```
data(syph)
plot(ts(syph$a33), main = "Maryland")
```

---

zim

*Fitting Zero-Inflated Models*

---

**Description**

zim is used to fit zero-inflated models.

**Usage**

```
zim(formula, data, subset, na.action, weights = 1, offset = 0,
    control = zim.control(...), ...)
```

**Arguments**

formula	an objective of class "formula".
data	an optional dataframe, list or environment containing the variables in the model.
subset	an optional vector specifying a subset of observations to be used in the fitting process.
na.action	a function which indicates what should happen when the data contain NAs.
weights	an optional vector of 'prior weights' to be used in the fitting process.
offset	this can be used to specify a priori known component to be included in the linear predictor during fitting.
control	control arguments.
...	additional arguments.

**Note**

zim is very similar to `zeroinfl` from the `pscl` package. Both functions can be used to fit observation-driven models for zero-inflated time series.

**See Also**

[zim.fit](#), [zim.control](#)

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zim.control	<i>Auxiliary for Controlling ZIM Fitting</i>
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---

### Description

Auxiliary function for `zim` fitting. Typically only used internally by `zim.fit`, but may be used to construct a control argument for either function.

### Usage

```
zim.control(dist = c("zip", "zinb"), method = c("EM-NR", "EM-FS"),
           type = c("solve", "ginv"), robust = FALSE, trace = FALSE,
           start = NULL, minit = 10, maxit = 10000, epsilon = 1e-08)
```

### Arguments

<code>dist</code>	count model family.
<code>method</code>	algorithm for parameter estimation.
<code>type</code>	type of matrix inverse.
<code>robust</code>	logical; if TRUE, robust standard errors will be calculated.
<code>trace</code>	logical; if TRUE, display iteration history.
<code>start</code>	initial parameter values.
<code>minit</code>	minimum number of iterations.
<code>maxit</code>	maximum number of iterations.
<code>epsilon</code>	positive convergence tolerance.

### See Also

[zim](#), [zim.fit](#)

---

zim.fit	<i>Fitter Function for Zero-Inflated Models</i>
---------	---

---

### Description

`zim.fit` is the basic computing engine called by `zim` used to fit zero-inflated models. This should usually *not* be used directly unless by experienced users.

### Usage

```
zim.fit(y, X, Z, weights = rep(1, nobs), offset = rep(0, nobs),
       control = zim.control(...), ...)
```

**Arguments**

y	response variable.
X	design matrix for log-linear part.
Z	design matrix for logistic part.
weights	an optional vector of 'prior weights' to be used in the fitting process.
offset	offset variable
control	control arguments from <a href="#">zim.control</a> .
...	additional argumetns.

**See Also**

[zim](#), [zim.control](#)

---

ZINB

*The Zero-Inflated Negative Binomial Distribution*


---

**Description**

Density, distribution function, quantile function and random generation for the zero-inflated negative binomial (ZINB) distribution with parameters k, lambda, and omega.

**Usage**

```
dzinb(x, k, lambda, omega, log = FALSE)
pzinb(q, k, lambda, omega, lower.tail = TRUE, log.p = FALSE)
qzinb(p, k, lambda, omega, lower.tail = TRUE, log.p = FALSE)
rzinb(n, k, lambda, omega)
```

**Arguments**

x, q	vector of quantiles.
p	vector of probabilities.
n	number of random values to return.
k	dispersion parameter.
lambda	vector of (non-negative) means.
omega	zero-inflation parameter.
log, log.p	logical; if TRUE, probabilities p are given as log(p).
lower.tail	logical; if TRUE (default), probabilities are $P[X \leq x]$ , otherwise, $P[X > x]$ .

**Value**

dzinb gives the density, pzinb gives the distribution function, qzinb gives the quantile function, and rzinb generates random deviates.

**See Also**

[dzip](#), [pzip](#), [qzip](#), and [rzip](#) for the zero-inflated Poisson (ZIP) distribution.

**Examples**

```
dzinb(x = 0:10, k = 1, lambda = 1, omega = 0.5)
pzinb(q = c(1, 5, 9), k = 1, lambda = 1, omega = 0.5)
qzinb(p = c(0.25, 0.50, 0.75), k = 1, lambda = 1, omega = 0.5)
set.seed(123)
rzinb(n = 100, k = 1, lambda = 1, omega = 0.5)
```

---

 ZIP

*The Zero-Inflated Poisson Distribution*


---

**Description**

Density, distribution function, quantile function and random generation for the zero-inflated Poisson (ZIP) distribution with parameters `lambda` and `omega`.

**Usage**

```
dzip(x, lambda, omega, log = FALSE)
pzip(q, lambda, omega, lower.tail = TRUE, log.p = FALSE)
qzip(p, lambda, omega, lower.tail = TRUE, log.p = FALSE)
rzip(n, lambda, omega)
```

**Arguments**

<code>x, q</code>	vector of quantiles.
<code>p</code>	vector of probabilities.
<code>n</code>	number of random values to return.
<code>lambda</code>	vector of (non-negative) means.
<code>omega</code>	zero-inflation parameter.
<code>log, log.p</code>	logical; if TRUE, probabilities <code>p</code> are given as $\log(p)$ .
<code>lower.tail</code>	logical; if TRUE (default), probabilities are $P[X \leq x]$ , otherwise, $P[X > x]$ .

**Value**

`dzip` gives the density, `pzip` gives the distribution function, `qzip` gives the quantile function, and `rzip` generates random deviates.

**See Also**

[dzinb](#), [pzinb](#), [qzinb](#), and [rzinb](#) for the zero-inflated negative binomial (ZINB) distribution.

**Examples**

```
dzip(x = 0:10, lambda = 1, omega = 0.5)
pzip(q = c(1, 5, 9), lambda = 1, omega = 0.5)
qzip(p = c(0.25, 0.50, 0.75), lambda = 1, omega = 0.5)
set.seed(123)
rzip(n = 100, lambda = 1, omega = 0.5)
```

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