

# Package ‘fitCTVARMx’

August 8, 2024

**Title** Fit the Continuous-Time Vector Autoregressive Model

**Version** 0.0.0.9000

**Description** Fit the continuous-time vector autoregressive model using the 'OpenMx' package.

**URL** <https://github.com/jeksterslab/fitCTVARMx>,  
<https://jeksterslab.github.io/fitCTVARMx/>

**BugReports** <https://github.com/jeksterslab/fitCTVARMx/issues>

**License** MIT + file LICENSE

**Encoding** UTF-8

**Roxygen** list(markdown = TRUE)

**VignetteBuilder** knitr

**Depends** R (>= 3.0.0), OpenMx

**Imports** stats

**Suggests** knitr, rmarkdown, testthat, simStateSpace

**RoxygenNote** 7.3.2

**NeedsCompilation** no

**Author** Ivan Jacob Agaloos Pesigan [aut, cre, cph]  
(<https://orcid.org/0000-0003-4818-8420>)

**Maintainer** Ivan Jacob Agaloos Pesigan <r.jeksterslab@gmail.com>

## Contents

coef.fitctvaridmx . . . . .	2
coef.fitctvarmx . . . . .	2
FitCTVARIDMx . . . . .	3
FitCTVARMx . . . . .	6
print.fitctvaridmx . . . . .	10
print.fitctvarmx . . . . .	11
summary.fitctvaridmx . . . . .	11
summary.fitctvarmx . . . . .	12
vcov.fitctvaridmx . . . . .	12
vcov.fitctvarmx . . . . .	13

---

coef.fitctvaridmx	Parameter Estimates
-------------------	---------------------

---

Description

Parameter Estimates

Usage

```
## S3 method for class 'fitctvaridmx'  
coef(object, iota = FALSE, sigma = FALSE, theta = FALSE, ...)
```

Arguments

object	Object of class fitctvaridmx.
iota	Logical. If iota = TRUE, include estimates of the iota vector, if available. If iota = FALSE, exclude estimates of the iota vector.
sigma	Logical. If sigma = TRUE, include estimates of the sigma matrix, if available. If sigma = FALSE, exclude estimates of the sigma matrix.
theta	Logical. If theta = TRUE, include estimates of the theta matrix, if available. If theta = FALSE, exclude estimates of the theta matrix.
...	additional arguments.

Value

Returns a list of vectors of parameter estimates.

Author(s)

Ivan Jacob Agaloos Pesigan

---

coef.fitctvarmx	Parameter Estimates
-----------------	---------------------

---

Description

Parameter Estimates

Usage

```
## S3 method for class 'fitctvarmx'  
coef(object, iota = FALSE, sigma = FALSE, theta = FALSE, ...)
```

**Arguments**

object	Object of class fitctvarmx.
iota	Logical. If iota = TRUE, include estimates of the iota vector, if available. If iota = FALSE, exclude estimates of the iota vector.
sigma	Logical. If sigma = TRUE, include estimates of the sigma matrix, if available. If sigma = FALSE, exclude estimates of the sigma matrix.
theta	Logical. If theta = TRUE, include estimates of the theta matrix, if available. If theta = FALSE, exclude estimates of the theta matrix.
...	additional arguments.

**Value**

Returns a vector of parameter estimates.

**Author(s)**

Ivan Jacob Agaloos Pesigan

---

FitCTVARIDMx	<i>Fit the First Order Continuous-Time Vector Autoregressive Model by ID</i>
--------------	--

---

**Description**

Fit the First Order Continuous-Time Vector Autoregressive Model by ID

**Usage**

```
FitCTVARIDMx(
  data,
  observed,
  id,
  time,
  iota_fixed = TRUE,
  iota_values = NULL,
  iota_lbound = NULL,
  iota_ubound = NULL,
  phi_values = NULL,
  phi_lbound = NULL,
  phi_ubound = NULL,
  sigma_diag = TRUE,
  sigma_values = NULL,
  sigma_lbound = NULL,
  sigma_ubound = NULL,
  theta_fixed = TRUE,
  theta_values = NULL,
```

```

    theta_lbound = NULL,
    theta_ubound = NULL,
    mu0_fixed = TRUE,
    mu0_values = NULL,
    mu0_lbound = NULL,
    mu0_ubound = NULL,
    sigma0_fixed = TRUE,
    sigma0_diag = TRUE,
    sigma0_values = NULL,
    sigma0_lbound = NULL,
    sigma0_ubound = NULL,
    try = 1000,
    ncores = NULL,
    ...
)

```

### Arguments

data	Data frame. A data frame object of data for potentially multiple subjects that contain a column of subject ID numbers (i.e., an ID variable), and at least one column of observed values.
observed	Character vector. A vector of character strings of the names of the observed variables in the data.
id	Character string. A character string of the name of the ID variable in the data.
time	Character string. A character string of the name of the TIME variable in the data.
iota_fixed	Logical. If <code>iota_fixed = TRUE</code> , the dynamic model intercept vector <code>iota</code> is fixed at zero. If <code>iota_fixed = FALSE</code> , the dynamic model intercept vector <code>iota</code> is estimated.
iota_values	Optional starting values for <code>iota</code> . If <code>iota_fixed = TRUE</code> , <code>iota_values</code> will be used as fixed values. If <code>iota_fixed = FALSE</code> , <code>iota_values</code> will be used as starting values.
iota_lbound	Optional lower bound for <code>iota</code> . Ignored if <code>iota_fixed = TRUE</code> .
iota_ubound	Optional upper bound for <code>iota</code> . Ignored if <code>iota_fixed = TRUE</code> .
phi_values	Numeric matrix. Optional starting values for <code>phi</code> .
phi_lbound	Numeric matrix. Optional lower bound for <code>phi</code> .
phi_ubound	Numeric matrix. Optional upper bound for <code>phi</code> .
sigma_diag	Logical. If <code>sigma_diag = TRUE</code> , <code>sigma</code> is a diagonal matrix.
sigma_values	Numeric matrix. Optional starting values for <code>sigma</code> .
sigma_lbound	Numeric matrix. Optional lower bound for <code>sigma</code> .
sigma_ubound	Optional upper bound for <code>sigma</code> .
theta_fixed	Logical. If <code>theta_fixed = TRUE</code> , the measurement error matrix <code>theta</code> is fixed to zero. If <code>theta_fixed = FALSE</code> , estimate the diagonal measurement error matrix <code>theta</code> .

theta_values	Optional starting values for theta. Ignored if theta_fixed = TRUE.
theta_lbound	Optional lower bound for theta. Ignored if theta_fixed = TRUE.
theta_ubound	Optional upper bound for theta. Ignored if theta_fixed = TRUE.
mu0_fixed	Logical. If mu0_fixed = TRUE, initial mean vector mu0 is fixed. If mu0_fixed = FALSE, initial mean vector mu0 is estimated.
mu0_values	Optional starting values for mu0. If mu0_fixed = TRUE, mu0_values will be used as fixed values. If mu0_fixed = FALSE, mu0_values will be used as starting values.
mu0_lbound	Optional lower bound for mu0. Ignored if mu0_fixed = TRUE.
mu0_ubound	Optional upper bound for mu0. Ignored if mu0_fixed = TRUE.
sigma0_fixed	Logical. If sigma0_fixed = TRUE, initial mean vector sigma0 is fixed. If sigma0_fixed = FALSE, initial mean vector sigma0 is estimated.
sigma0_diag	Logical. If sigma0_diag = TRUE, sigma0 is a diagonal matrix.
sigma0_values	Optional starting values for sigma0. If sigma0_fixed = TRUE, sigma0_values will be used as fixed values. If sigma0_fixed = FALSE, sigma0_values will be used as starting values.
sigma0_lbound	Optional lower bound for sigma0. Ignored if sigma0_fixed = TRUE.
sigma0_ubound	Optional upper bound for sigma0. Ignored if sigma0_fixed = TRUE.
try	Positive integer. Number of extra optimization tries.
ncores	Positive integer. Number of cores to use.
...	Additional optional arguments to pass to mxTryHardctsem.

### Author(s)

Ivan Jacob Agaloos Pesigan

### References

- Hunter, M. D. (2017). State space modeling in an open source, modular, structural equation modeling environment. *Structural Equation Modeling: A Multidisciplinary Journal*, 25(2), 307–324. doi:10.1080/10705511.2017.1369354
- Neale, M. C., Hunter, M. D., Pritikin, J. N., Zahery, M., Brick, T. R., Kirkpatrick, R. M., Estabrook, R., Bates, T. C., Maes, H. H., & Boker, S. M. (2015). OpenMx 2.0: Extended structural equation and statistical modeling. *Psychometrika*, 81(2), 535–549. doi:10.1007/s1133601494358

### See Also

Other CTVAR Functions: [FitCTVARMx\(\)](#)

### Examples

```
## Not run:
# Generate data using the simStateSpace package-----
set.seed(42)
phi_mu <- matrix(
```

```

data = c(
  -0.357, 0.771, -0.450,
  0.0, -0.511, 0.729,
  0, 0, -0.693
),
nrow = 3
)
phi_sigma <- diag(3 * 3)
phi <- simStateSpace::SimPhiN(
  n = 5,
  phi = phi_mu,
  vcov_phi_vec_l = t(chol(phi_sigma))
)
sim <- simStateSpace::SimSSMOUIVary(
  n = 5,
  time = 100,
  delta_t = 0.10,
  mu0 = list(rep(x = 0, times = 3)),
  sigma0_l = list(t(chol(diag(3)))),
  mu = list(rep(x = 0, times = 3)),
  phi = phi,
  sigma_l = list(t(chol(diag(3)))),
  nu = list(rep(x = 0, times = 3)),
  lambda = list(diag(3)),
  theta_l = list(matrix(data = 0, nrow = 3, ncol = 3))
)
data <- as.data.frame(sim)

# Fit the model-----
library(fitCTVARMx)
fit <- FitCTVARIDMx(
  data = data,
  observed = c("y1", "y2", "y3"),
  id = "id"
)
print(fit)
summary(fit)
coef(fit)
vcov(fit)

## End(Not run)

```

---

FitCTVARMx

---

*Fit the First-Order Continuous-Time Vector Autoregressive Model*


---

## Description

Fit the First-Order Continuous-Time Vector Autoregressive Model

**Usage**

```
FitCTVARMx(
  data,
  observed,
  id,
  time,
  iota_fixed = TRUE,
  iota_values = NULL,
  iota_lbound = NULL,
  iota_ubound = NULL,
  phi_values = NULL,
  phi_lbound = NULL,
  phi_ubound = NULL,
  sigma_diag = TRUE,
  sigma_values = NULL,
  sigma_lbound = NULL,
  sigma_ubound = NULL,
  theta_fixed = TRUE,
  theta_values = NULL,
  theta_lbound = NULL,
  theta_ubound = NULL,
  mu0_fixed = TRUE,
  mu0_values = NULL,
  mu0_lbound = NULL,
  mu0_ubound = NULL,
  sigma0_fixed = TRUE,
  sigma0_diag = TRUE,
  sigma0_values = NULL,
  sigma0_lbound = NULL,
  sigma0_ubound = NULL,
  try = 1000,
  ncores = NULL,
  ...
)
```

**Arguments**

<code>data</code>	Data frame. A data frame object of data for potentially multiple subjects that contain a column of subject ID numbers (i.e., an ID variable), and at least one column of observed values.
<code>observed</code>	Character vector. A vector of character strings of the names of the observed variables in the data.
<code>id</code>	Character string. A character string of the name of the ID variable in the data.
<code>time</code>	Character string. A character string of the name of the TIME variable in the data.
<code>iota_fixed</code>	Logical. If <code>iota_fixed = TRUE</code> , the dynamic model intercept vector <code>iota</code> is fixed at zero. If <code>iota_fixed = FALSE</code> , the dynamic model intercept vector <code>iota</code>

	is estimated.
iota_values	Optional starting values for iota. If <code>iota_fixed = TRUE</code> , <code>iota_values</code> will be used as fixed values. If <code>iota_fixed = FALSE</code> , <code>iota_values</code> will be used as starting values.
iota_lbound	Optional lower bound for iota. Ignored if <code>iota_fixed = TRUE</code> .
iota_ubound	Optional upper bound for iota. Ignored if <code>iota_fixed = TRUE</code> .
phi_values	Numeric matrix. Optional starting values for phi.
phi_lbound	Numeric matrix. Optional lower bound for phi.
phi_ubound	Numeric matrix. Optional upper bound for phi.
sigma_diag	Logical. If <code>sigma_diag = TRUE</code> , <code>sigma</code> is a diagonal matrix.
sigma_values	Numeric matrix. Optional starting values for sigma.
sigma_lbound	Numeric matrix. Optional lower bound for sigma.
sigma_ubound	Optional upper bound for sigma.
theta_fixed	Logical. If <code>theta_fixed = TRUE</code> , the measurement error matrix <code>theta</code> is fixed to zero. If <code>theta_fixed = FALSE</code> , estimate the diagonal measurement error matrix <code>theta</code> .
theta_values	Optional starting values for theta. Ignored if <code>theta_fixed = TRUE</code> .
theta_lbound	Optional lower bound for theta. Ignored if <code>theta_fixed = TRUE</code> .
theta_ubound	Optional upper bound for theta. Ignored if <code>theta_fixed = TRUE</code> .
mu0_fixed	Logical. If <code>mu0_fixed = TRUE</code> , initial mean vector <code>mu0</code> is fixed. If <code>mu0_fixed = FALSE</code> , initial mean vector <code>mu0</code> is estimated.
mu0_values	Optional starting values for <code>mu0</code> . If <code>mu0_fixed = TRUE</code> , <code>mu0_values</code> will be used as fixed values. If <code>mu0_fixed = FALSE</code> , <code>mu0_values</code> will be used as starting values.
mu0_lbound	Optional lower bound for <code>mu0</code> . Ignored if <code>mu0_fixed = TRUE</code> .
mu0_ubound	Optional upper bound for <code>mu0</code> . Ignored if <code>mu0_fixed = TRUE</code> .
sigma0_fixed	Logical. If <code>sigma0_fixed = TRUE</code> , initial mean vector <code>sigma0</code> is fixed. If <code>sigma0_fixed = FALSE</code> , initial mean vector <code>sigma0</code> is estimated.
sigma0_diag	Logical. If <code>sigma0_diag = TRUE</code> , <code>sigma0</code> is a diagonal matrix.
sigma0_values	Optional starting values for <code>sigma0</code> . If <code>sigma0_fixed = TRUE</code> , <code>sigma0_values</code> will be used as fixed values. If <code>sigma0_fixed = FALSE</code> , <code>sigma0_values</code> will be used as starting values.
sigma0_lbound	Optional lower bound for <code>sigma0</code> . Ignored if <code>sigma0_fixed = TRUE</code> .
sigma0_ubound	Optional upper bound for <code>sigma0</code> . Ignored if <code>sigma0_fixed = TRUE</code> .
try	Positive integer. Number of extra optimization tries.
ncores	Positive integer. Number of cores to use.
...	Additional optional arguments to pass to <code>mTryHardctsem</code> .



**Value**

Returns an object of class `fitctvarmx` which is a list with the following elements:

**call** Function call.

**args** List of function arguments.

**fun** Function used ("FitCTVARMx").

**output** A fitted OpenMx model.

**Author(s)**

Ivan Jacob Agaloos Pesigan

**References**

Hunter, M. D. (2017). State space modeling in an open source, modular, structural equation modeling environment. *Structural Equation Modeling: A Multidisciplinary Journal*, 25(2), 307–324. doi:[10.1080/10705511.2017.1369354](https://doi.org/10.1080/10705511.2017.1369354)

Neale, M. C., Hunter, M. D., Pritikin, J. N., Zahery, M., Brick, T. R., Kirkpatrick, R. M., Estabrook, R., Bates, T. C., Maes, H. H., & Boker, S. M. (2015). OpenMx 2.0: Extended structural equation and statistical modeling. *Psychometrika*, 81(2), 535–549. doi:[10.1007/s1133601494358](https://doi.org/10.1007/s1133601494358)

**See Also**

Other CTVAR Functions: [FitCTVARIDMx\(\)](#)

**Examples**

```
## Not run:
# Generate data using the simStateSpace package-----
set.seed(42)
sim <- simStateSpace::SimSSMOUFixed(
  n = 5,
  time = 100,
  delta_t = 0.10,
  mu0 = rep(x = 0, times = 3),
  sigma0_l = t(chol(diag(3))),
  mu = rep(x = 0, times = 3),
  phi = matrix(
    data = c(
      -0.357, 0.771, -0.450,
      0.0, -0.511, 0.729,
      0, 0, -0.693
    ),
    nrow = 3
  ),
  sigma_l = t(chol(diag(3))),
  nu = rep(x = 0, times = 3),
  lambda = diag(3),
  theta_l = matrix(data = 0, nrow = 3, ncol = 3)
)
```

```

data <- as.data.frame(sim)

# Fit the model-----
library(fitCTVARMx)
fit <- FitCTVARMx(
  data = data,
  observed = c("y1", "y2", "y3"),
  id = "id"
)
print(fit)
summary(fit)
coef(fit)
vcov(fit)

## End(Not run)

```

---

<code>print.fitctvaridmx</code>	<i>Print Method for Object of Class fitctvaridmx</i>
---------------------------------	--

---

## Description

Print Method for Object of Class `fitctvaridmx`

## Usage

```

## S3 method for class 'fitctvaridmx'
print(x, means = TRUE, ...)

```

## Arguments

<code>x</code>	an object of class <code>fitctvaridmx</code> .
<code>means</code>	Logical. If <code>means = TRUE</code> , return means. Otherwise, the function returns raw estimates.
<code>...</code>	further arguments.

## Author(s)

Ivan Jacob Agaloos Pesigan

---

print.fitctvarmx	<i>Print Method for Object of Class fitctvarmx</i>
------------------	--

---

**Description**

Print Method for Object of Class fitctvarmx

**Usage**

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

**Arguments**

x	an object of class fitctvarmx.
...	further arguments.

**Author(s)**

Ivan Jacob Agaloos Pesigan

---

summary.fitctvaridmx	<i>Summary Method for Object of Class fitctvaridmx</i>
----------------------	--

---

**Description**

Summary Method for Object of Class fitctvaridmx

**Usage**

```
## S3 method for class 'fitctvaridmx'
summary(object, means = TRUE, ...)
```

**Arguments**

object	an object of class fitctvaridmx.
means	Logical. If means = TRUE, return means. Otherwise, the function returns raw estimates.
...	further arguments.

**Author(s)**

Ivan Jacob Agaloos Pesigan

---

summary.fitctvarmx	<i>Summary Method for Object of Class fitctvarmx</i>
--------------------	--

---

**Description**

Summary Method for Object of Class fitctvarmx

**Usage**

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

**Arguments**

object	an object of class fitctvarmx.
...	further arguments.

**Author(s)**

Ivan Jacob Agaloos Pesigan

---

vcov.fitctvaridmx	<i>Sampling Covariance Matrix of the Parameter Estimates</i>
-------------------	--

---

**Description**

Sampling Covariance Matrix of the Parameter Estimates

**Usage**

```
## S3 method for class 'fitctvaridmx'
vcov(object, iota = FALSE, sigma = FALSE, theta = FALSE, ...)
```

**Arguments**

object	Object of class fitctvaridmx.
iota	Logical. If iota = TRUE, include estimates of the iota vector, if available. If iota = FALSE, exclude estimates of the iota vector.
sigma	Logical. If sigma = TRUE, include estimates of the sigma matrix, if available. If sigma = FALSE, exclude estimates of the sigma matrix.
theta	Logical. If theta = TRUE, include estimates of the theta matrix, if available. If theta = FALSE, exclude estimates of the theta matrix.
...	additional arguments.

**Value**

Returns a list of sampling variance-covariance matrices.

**Author(s)**

Ivan Jacob Agaloos Pesigan

---

vcov.fitctvarmx

*Sampling Covariance Matrix of the Parameter Estimates*


---

**Description**

Sampling Covariance Matrix of the Parameter Estimates

**Usage**

```
## S3 method for class 'fitctvarmx'
vcov(object, iota = FALSE, sigma = FALSE, theta = FALSE, ...)
```

**Arguments**

object	Object of class fitctvarmx.
iota	Logical. If iota = TRUE, include estimates of the iota vector, if available. If iota = FALSE, exclude estimates of the iota vector.
sigma	Logical. If sigma = TRUE, include estimates of the sigma matrix, if available. If sigma = FALSE, exclude estimates of the sigma matrix.
theta	Logical. If theta = TRUE, include estimates of the theta matrix, if available. If theta = FALSE, exclude estimates of the theta matrix.
...	additional arguments.

**Value**

Returns a list of sampling variance-covariance matrices.

**Author(s)**

Ivan Jacob Agaloos Pesigan

# Index

## \* CTVAR Functions

FitCTVARIDMx, [3](#)

FitCTVARMx, [6](#)

## \* fitCTVARMx

FitCTVARIDMx, [3](#)

FitCTVARMx, [6](#)

## \* fit

FitCTVARIDMx, [3](#)

FitCTVARMx, [6](#)

## \* methods

coef.fitctvaridmx, [2](#)

coef.fitctvarmx, [2](#)

print.fitctvaridmx, [10](#)

print.fitctvarmx, [11](#)

summary.fitctvaridmx, [11](#)

summary.fitctvarmx, [12](#)

vcov.fitctvaridmx, [12](#)

vcov.fitctvarmx, [13](#)

coef.fitctvaridmx, [2](#)

coef.fitctvarmx, [2](#)

FitCTVARIDMx, [3](#), [9](#)

FitCTVARMx, [5](#), [6](#)

print.fitctvaridmx, [10](#)

print.fitctvarmx, [11](#)

summary.fitctvaridmx, [11](#)

summary.fitctvarmx, [12](#)

vcov.fitctvaridmx, [12](#)

vcov.fitctvarmx, [13](#)