

Package ‘SVARtca’

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Title Transmission Channel Analysis in Structural VAR Models

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Description Implements Transmission Channel Analysis (TCA) for structural vector autoregressive (SVAR) models following the methodology of Wegner, Lieb, and Smeekes (2025) <[doi:10.48550/arXiv.2405.18987](https://doi.org/10.48550/arXiv.2405.18987)>. TCA decomposes impulse response functions (IRFs) into contributions from distinct transmission channels using a systems form representation and directed acyclic graph (DAG) path analysis. Supports overlapping channels, exhaustive 3-way and 4-way decompositions via inclusion-exclusion principle. This is a parallel R implementation of the 'tca-matlab-toolbox' (<<https://github.com/enweg/tca-matlab-toolbox>>).

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URL <https://github.com/muhammedalkhalaf/SVARtca>

BugReports <https://github.com/muhammedalkhalaf/SVARtca/issues>

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Author Muhammad Alkhalaf [aut, cre] (ORCID:
<<https://orcid.org/0009-0002-2677-9246>>),
Emanuel Wegner [ctb] (Original MATLAB toolbox author),
Lenard Lieb [ctb] (Original MATLAB toolbox author),
Stephan Smeekes [ctb] (Original MATLAB toolbox author)

Maintainer Muhammad Alkhalaf <muhammedalkhalaf@gmail.com>

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SVARtca-package	<i>Transmission Channel Analysis in Structural VAR Models</i>
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Description

The SVARtca package implements Transmission Channel Analysis (TCA) for decomposing impulse response functions in structural vector autoregressive (SVAR) models. The package follows the methodology presented in Wegner, Lieb, Smeekes (2025).

TCA enables researchers to decompose the total impulse response to a shock into contributions from different transmission channels. Supported channels include effects passing through specific intermediate variables, allowing analysts to distinguish direct effects from indirect effects that operate through identified transmission mechanisms.

Key features:

- Multiple decomposition modes: overlapping, exhaustive 3-way, and exhaustive 4-way.
- Support for VAR and SVAR models via integration with the **vars** package.
- Visualization of channel contributions using **ggplot2**.
- Diagnostic tools for validating decomposition accuracy.

Main Functions

tca_systems_form Build the systems form representation (B and Omega matrices) from VAR coefficients and structural impact matrix.

tca_analyze Run the main TCA analysis with specified decomposition mode.

tca_decompose_binary Decompose IRF into "through" and "not_through" components for a single variable.

tca_validate_additivity Validate that the binary decomposition satisfies exact additivity.

tca_from_var Convenience wrapper to run TCA directly from a fitted VAR model object.

plot_tca Create publication-quality visualizations of channel contributions.

Identification

The package supports two identification schemes:

- **Cholesky**: Lower-triangular Cholesky decomposition of the residual covariance matrix. Set $\Phi_0 = t(\text{chol}(\text{Sigma}))$.
- **Manual**: User-supplied structural impact matrix for alternative identifications (e.g., sign restrictions, zero restrictions).

Citation

If you use the SVARtca package in your research, please cite the original methodology paper:

Wegner, E., Lieb, L., Smeekes, S. (2025). *Transmission Channel Analysis in Dynamic Models*. arXiv:2405.18987. <https://github.com/enweg/tca-matlab-toolbox>

Author(s)

Muhammad Alkhalaf

References

Wegner, E., Lieb, L., Smeekes, S. (2025). *Transmission Channel Analysis in Dynamic Models*. arXiv:2405.18987.

plot_tca

Plot TCA Channel Decomposition

Description

Creates a stacked bar chart (for exhaustive modes) or a line chart (for overlapping mode) showing channel contributions over horizons.

Usage

```
plot_tca(x, target = NULL, type = NULL, title = NULL,
         colors = NULL)
```

Arguments

x	A tca_result object from tca_analyze .
target	Integer index of the response variable to plot (default: first variable after shock).
type	Plot type: "bar" for stacked bar chart (default for exhaustive modes), "line" for overlaid lines (default for overlapping mode). If NULL, chosen automatically.
title	Custom plot title (optional).
colors	Named character vector of colours for channels (optional).

Value

A ggplot object.

Examples

```
K <- 4
A1 <- matrix(c(0.7,-0.1,0.05,-0.05, -0.3,0.6,0.10,-0.10,
              -0.2,0.1,0.70,0.05, -0.1,0.2,0.05,0.65), K, K, byrow=TRUE)
Sigma <- matrix(c(1,0.3,0.2,0.1, 0.3,1.5,0.25,0.15,
                 0.2,0.25,0.8,0.1, 0.1,0.15,0.1,0.6), K, K, byrow=TRUE)
Phi0 <- t(chol(Sigma))
sf <- tca_systems_form(Phi0, list(A1), h = 20)
res <- tca_analyze(from = 1, B = sf$B, Omega = sf$Omega,
                  intermediates = c(2, 4), K = K, h = 20,
                  order = 1:K, mode = "exhaustive_4way",
                  var_names = c("IntRate", "GDP", "Inflation", "Wages"))
plot_tca(res, target = 3)
```

print.tca_result

Print TCA Result

Description

S3 print method for tca_result objects. Displays a formatted table of transmission channel contributions across horizons.

Usage

```
## S3 method for class 'tca_result'
print(x, target = NULL, ...)
```

Arguments

x	A tca_result object.
target	Target variable to display (default: first intermediate).
...	Additional arguments (ignored).

Value

Invisibly returns x.

tca_analyze	<i>Transmission Channel Analysis</i>
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Description

Decomposes impulse response functions into transmission channel contributions using the methodology of Wegner, Lieb, Smeekes (2025).

Three decomposition modes are supported:

"overlapping" Each channel is $\text{through}(j) = \text{total} - \text{not_through}(j)$. Channels may overlap, so their sum may differ from the total.

"exhaustive_3way" (2 intermediates only) Non-overlapping: (1) through var1 inclusive, (2) through var2 only, (3) direct. Sum equals total.

"exhaustive_4way" (2 intermediates only) Full inclusion-exclusion: (1) var1 only, (2) var2 only, (3) both, (4) direct. Sum equals total.

Usage

```
tca_analyze(from, B, Omega, intermediates, K, h, order,
            mode = "overlapping", var_names = NULL)
```

Arguments

from	Shock variable number (1-based).
B	Systems form B matrix (from tca_systems_form).
Omega	Systems form Omega matrix.
intermediates	Integer vector of intermediate variable numbers (1-based, original ordering).
K	Number of variables.
h	Maximum horizon.
order	Transmission ordering vector.
mode	Decomposition mode: "overlapping", "exhaustive_3way", or "exhaustive_4way".
var_names	Character vector of variable names (optional).

Value

A list of class "tca_result" with components:

irf_total Matrix $(h+1) \times K$ of total IRFs.

irf_channels Named list of channel IRF matrices, each $(h+1) \times K$.

channel_names Character vector of channel names.

mode Decomposition mode used.

from Shock variable number.

K Number of variables.

h Maximum horizon.

order Transmission ordering.

var_names Variable names.

References

Wegner, E., Lieb, L., Smeekes, S. (2025). *Transmission Channel Analysis in Dynamic Models*. arXiv:2405.18987.

Examples

```
# Monetary policy model
K <- 4
A1 <- matrix(c(0.7,-0.1,0.05,-0.05, -0.3,0.6,0.10,-0.10,
              -0.2,0.1,0.70,0.05, -0.1,0.2,0.05,0.65), K, K, byrow=TRUE)
Sigma <- matrix(c(1,0.3,0.2,0.1, 0.3,1.5,0.25,0.15,
                 0.2,0.25,0.8,0.1, 0.1,0.15,0.1,0.6), K, K, byrow=TRUE)
Phi0 <- t(chol(Sigma))
sf <- tca_systems_form(Phi0, list(A1), h = 20)
result <- tca_analyze(from = 1, B = sf$B, Omega = sf$Omega,
                     intermediates = c(2, 4), K = K, h = 20,
                     order = 1:K, mode = "exhaustive_4way",
                     var_names = c("IntRate","GDP","Inflation","Wages"))

print(result)
```

tca_decompose_binary *Binary Decomposition: Total = Through + Not-Through*

Description

Decomposes the total IRF into the effect passing through a variable and the effect not passing through it. This is an exact decomposition (residual is zero at machine precision).

Usage

```
tca_decompose_binary(from, B, Omega, var_idx, K, h, order)
```

Arguments

from	Shock variable (1-based).
B	Systems form B matrix.
Omega	Systems form Omega matrix.
var_idx	Variable to decompose through (1-based).
K	Number of variables.
h	Maximum horizon.
order	Transmission ordering.

Value

A list with matrices total, through, not_through (each (h+1) x K).

tca_from_var

Run TCA from a VAR Estimation Object

Description

Extracts coefficient matrices and residual covariance from a fitted VAR model (from the **vars** package) and runs TCA.

Usage

```
tca_from_var(var_model, from, intermediates, h = 20,
             order = NULL, mode = "overlapping",
             identification = "cholesky", Phi0 = NULL)
```

Arguments

var_model	A fitted VAR model object from VAR .
from	Shock variable (integer or name).
intermediates	Integer vector or character vector of intermediate variable names.
h	Maximum horizon (default: 20).
order	Transmission ordering (default: variable ordering in the VAR).
mode	Decomposition mode: "overlapping", "exhaustive_3way", or "exhaustive_4way".
identification	Identification scheme: "cholesky" (default) or "manual".
Phi0	Manual impact matrix. Required if identification = "manual".

Value

A `tca_result` object (see [tca_analyze](#)).

Examples

```
library(vars)
data(Canada)
var_est <- VAR(Canada, p = 2, type = "const")
result <- tca_from_var(var_est, from = "e",
                      intermediates = c("prod", "rw"),
                      h = 20, mode = "exhaustive_4way")
plot_tca(result, target = "U")
```

tca_systems_form *Build Complete Systems Form*

Description

Constructs both B and Omega matrices for the systems form representation $x = Bx + \text{Omega} * \text{epsilon}$, following the methodology of Wegner, Lieb, Smeekes (2025).

Usage

```
tca_systems_form(Phi0, As, h, order = NULL, Psis = NULL)
```

Arguments

Phi0	Structural impact matrix (K x K). For Cholesky identification, use <code>t(chol(Sigma))</code> .
As	List of VAR coefficient matrices (A_1, A_2, ..., A_p).
h	Maximum IRF horizon.
order	Transmission ordering vector (default: 1:K).
Psis	List of reduced-form MA coefficients (optional, for DSGE/VARMA models).

Value

A list with components:

B Systems form B matrix ($K*(h+1) \times K*(h+1)$).

Omega Systems form Omega matrix ($K*(h+1) \times K*(h+1)$).

References

Wegner, E., Lieb, L., Smeekes, S. (2025). *Transmission Channel Analysis in Dynamic Models*. arXiv:2405.18987. <https://github.com/enweg/tca-matlab-toolbox>

Examples

```
# 2-variable VAR(1)
Phi0 <- matrix(c(1, 0.3, 0, 0.95), 2, 2)
As <- list(matrix(c(0.5, -0.1, 0.2, 0.4), 2, 2))
sf <- tca_systems_form(Phi0, As, h = 10)
dim(sf$B) # 22 x 22
```

`tca_validate_additivity`*Validate Binary Additivity*

Description

Tests that $\text{total} = \text{through}(j) + \text{not_through}(j)$ holds for all variables at machine precision. This is a diagnostic to verify correct implementation.

Usage

```
tca_validate_additivity(from, B, Omega, K, h, order,  
var_names = NULL, verbose = TRUE)
```

Arguments

<code>from</code>	Shock variable (1-based).
<code>B</code>	Systems form B matrix.
<code>Omega</code>	Systems form Omega matrix.
<code>K</code>	Number of variables.
<code>h</code>	Maximum horizon.
<code>order</code>	Transmission ordering.
<code>var_names</code>	Character vector of variable names (optional).
<code>verbose</code>	Logical; print results? Default TRUE.

Value

Invisibly returns TRUE if all tests pass.

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