Package: contagionchannels (via r-universe)

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Type Package

Title Two-Stage Detection and Attribution of Cross-Border Financial Contagion Channels

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Description Implementation of a two-stage framework for the joint detection-and-attribution of cross-border financial contagion. Stage one detects directional information flows between equity markets via Wavelet-Quantile Transfer Entropy, combining maximal-overlap discrete wavelet decomposition (Percival and Walden, 2000, ISBN:9780521685085) with the transfer-entropy estimator of Schreiber (2000) <doi:10.1103/PhysRevLett.85.461> and quantile conditioning following Han, Linton, Oka and Whang (2016) <doi:10.1016/j.jeconom.2016.03.001>. Stage two attributes each significant directional link to one of five mutually exclusive transmission channels (Trade, Financial, Geopolitical, Behavioural, Monetary Policy) through a multi-method structural identification architecture combining instrumental-variables two-stage least squares with channel-specific external instruments (Stock and Watson, 2018) <doi:10.1111/ecoj.12593>, LASSO-based instrument selection (Belloni, Chernozhukov and Hansen, 2014) <doi:10.1093/restud/rdt044>, local projections (Jorda, 2005) <doi:10.1257/0002828053828518>, heteroskedasticity-based identification (Rigobon, 2003) <doi:10.1162/003465303772815727>, and the Cinelli-Hazlett (2020) <doi:10.1111/rssb.12348> robustness-value sensitivity bound. Bundled datasets and replication scripts reproduce the headline findings of Bhandari, Parida and Sahu (2026) <doi:10.48550/arXiv.2604.26546>; the package is general-purpose and accommodates user-supplied returns and channel proxies.

License GPL-3

Encoding UTF-8

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Imports xts, zoo, waveslim, quantreg, igraph, parallel, MASS, stats, utils

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Contents

`build_channel_composites` *Construct the Five-Channel Composites*

Description

Builds the five contagion-channel composites (Trade, Financial, Geopolitical, Behavioural, Monetary Policy) from a data.frame of raw channel proxies. The construction is engineered for orthogonal identification: the trade composite uses log-returns of a broad trade-weighted dollar index (genuinely time-varying), the behavioural composite is orthogonalised against the financial composite to avoid VIX-derivative contamination, and the monetary composite uses a first-differenced policy rate to remove persistence-induced first-stage F-inflation.

Usage

```
build_channel_composites(proxy_grid)
```

Arguments

`proxy_grid`	A data.frame with the following columns aligned on the same daily date grid: `vix`, `hy_spread`, `stress_index`, `usd_index`, `gpr`, `geo_events`, `sentiment`, `fed_rate`, `term_spread`, `qe_dummy`.

Value

A data.frame with columns `Date`, `Trade`, `Financial`, `Geopolitical`, `Behavioral`, and `Monetary_Policy`; each composite is z-scored within sample.

References

Stock, J. H., & Watson, M. W. (2018). Identification and Estimation of Dynamic Causal Effects in Macroeconomics Using External Instruments. Economic Journal, 128(610), 917-948. doi: 10.1111/ecoj.12593.

Romer, C. D., & Romer, D. H. (2004). A New Measure of Monetary Shocks. American Economic Review, 94(4), 1055-1084. doi: 10.1257/0002828042002651.

Examples

```
d <- load_paper_data()
ch <- build_channel_composites(d$proxies)
head(ch); cor(ch[, -1])
```

---

build_lag — *Build a Lagged Vector with Leading NAs*

Description

Returns a vector $x_{t-\ell}$ where the first ℓ positions are `NA` and the remaining positions are the lagged values of `x`. Used throughout the package for instrument and predictor construction.

Usage

```
build_lag(x, lg)
```

Arguments

`x`	Numeric vector.
`lg`	Positive integer lag.

Value

Numeric vector of the same length as `x`.

Examples

```
build_lag(1:10, 3)
```

---

build_network — *Construct a Directed Contagion Network from a WQTE Flow Matrix*

Description

Builds a directed weighted network from a pairwise WQTE flow matrix by retaining only the edges whose intensity exceeds the supplied threshold. The network construction follows the standard contagion-network literature (Diebold and Yilmaz, 2014; Billio et al., 2012).

Usage

```
build_network(F_matrix, threshold)
```

Arguments

F_matrix — An $N \times N$ numeric matrix of WQTE values.

threshold — Numeric threshold for edge retention; edges with F_matrix[i,j] > threshold are retained.

Value

An igraph object with weight edge attribute equal to the WQTE value.

Examples

```
m <- matrix(runif(25, 0, 0.1), 5, 5); diag(m) <- 0
g <- build_network(m, threshold = 0.05)
igraph::ecount(g)
```

---

channel_proxies — *Channel-Proxy Daily Series*

Description

Daily-frequency channel-proxy series aligned on the G20 trading-day grid, used as inputs to build_channel_composites. Values are forward-filled where lower-frequency data are available.

Usage

```
channel_proxies
```

Format

A data.frame with 5,036 rows and 14 columns:

Date Trading date

vix CBOE Volatility Index level

hy_spread ICE BofA US High-Yield Option-Adjusted Spread

stress_index St. Louis Fed Financial Stress Index (STLFSI4)

usd_index Federal Reserve Broad Trade-Weighted Dollar Index (DTWEXBGS)

gpr Caldara-Iacoviello Geopolitical Risk Index

geo_events Geopolitical-events indicator

vix_slope VIX-VIX3M term-structure slope

fear_proxy Daily absolute change in VIX

sentiment University of Michigan Consumer Sentiment Index

fed_rate Effective Federal Funds Rate

dgs10 10-year Treasury yield

term_spread 10-year minus 3-month Treasury yield spread

qe_dummy Quantitative-easing program indicator (binary)

Source

Federal Reserve Economic Data (FRED), Yahoo Finance, Caldara-Iacoviello GPR data library.

Examples

```
data(channel_proxies)
summary(channel_proxies[, c("vix","gpr","fed_rate")])
```

`cinelli_hazlett_rv` *Cinelli-Hazlett Robustness Value*

Description

Computes the partial-R^2 that an unobserved confounder would need to share with both the treatment and the outcome to drive the structural coefficient to zero. The robustness value is bounded in [0, 1]; values near zero indicate that even a weakly correlated confounder could explain away the result, while values near one indicate identification-robust findings.

Usage

```
cinelli_hazlett_rv(theta, se, df)
```

Arguments

`theta`	Estimated structural coefficient.
`se`	Standard error of `theta`.
`df`	Residual degrees of freedom.

Value

A scalar in $[0, 1]$, or `NA` if inputs are invalid.

References

Cinelli, C., & Hazlett, C. (2020). Making Sense of Sensitivity: Extending Omitted Variable Bias. Journal of the Royal Statistical Society Series B, 82(1), 39-67. doi: 10.1111/rssb.12348.

Examples

```
cinelli_hazlett_rv(theta = 0.4, se = 0.1, df = 200)
```

`compute_wqte_matrix` *Wavelet-Quantile Transfer Entropy Matrix*

Description

Computes the bilateral WQTE matrix for a returns panel at one wavelet scale and one quantile, producing the directed flow matrix that serves as the Stage-1 input to the structural-attribution layer.

Usage

```
compute_wqte_matrix(returns, scale = 5, tau = 0.5, n_cores = 2L)
```

Arguments

`returns`	An xts or matrix of returns (rows = time, cols = markets).
`scale`	Integer wavelet scale. Default 5.
`tau`	Quantile level. Default 0.50.
`n_cores`	Integer; number of parallel cores for `mclapply`. Default `2L` per CRAN policy; on Windows the function falls back to serial `lapply`. Increase for production-scale workloads.

Value

An $N \times N$ matrix where entry (i, j) is the WQTE from market i to market j at the specified scale and quantile; row and column names are taken from `colnames(returns)`.

References

Bhandari, A., & Parida, I. (2026). Wavelet-quantile transfer entropy for financial-market contagion.

Examples

```
d <- load_paper_data()
ix <- which(zoo::index(d$returns) >= as.Date("2008-01-01") &
            zoo::index(d$returns) <= as.Date("2008-12-31"))
F <- compute_wqte_matrix(d$returns[ix, ], scale = 5, tau = 0.50, n_cores = 2)
```

`crisis_periods` *Crisis Sub-Period Definitions*

Description

A named list of length-two character vectors specifying the start and end dates of the eight crisis sub-periods analysed in the paper.

Usage

```
crisis_periods
```

Format

A named list with eight elements:

PreCrisis Pre-Crisis Baseline (12 Jan 2006 - 31 Jul 2007)

GFC Global Financial Crisis (1 Aug 2007 - 30 Jun 2009)

ESDC European Sovereign Debt Crisis (1 Dec 2009 - 30 Jun 2012)

CSC Chinese Stock Crash (15 Jun 2015 - 31 Dec 2016)

PreCOVID Pre-COVID interval (1 Jan 2017 - 31 Jan 2020)

COVID COVID-19 Pandemic (1 Feb 2020 - 31 Dec 2021)

RusUkr Russia-Ukraine episode (1 Feb 2022 - 31 Dec 2023)

MidEastTariffs Middle-East tensions and tariffs (1 Jan 2024 - 18 Mar 2026)

Examples

```
data(crisis_periods)
crisis_periods$GFC
```

`g20_returns` *G20 Equity-Market Daily Log-Returns*

Description

Daily log-return panel for 18 G20 equity-market indices spanning 12 January 2006 through 18 March 2026, used in the paper replication. The panel covers 5,036 trading days. Eight developed and ten emerging markets are represented.

Usage

```
g20_returns
```

Format

An xts object with 5,036 rows and 18 columns:

Argentina S&P/MERVAL log-returns

Australia S&P/ASX 200 log-returns

Brazil IBOVESPA log-returns

Canada S&P/TSX Composite log-returns

China Shanghai Composite log-returns

France CAC 40 log-returns

Germany DAX 40 log-returns

India BSE SENSEX log-returns

Indonesia IDX Composite log-returns

Italy FTSE MIB log-returns

Japan Nikkei 225 log-returns

Mexico S&P/BMV IPC log-returns

Russia IMOEX log-returns

SouthAfrica JSE All Share log-returns

SouthKorea KOSPI log-returns

Turkey BIST 100 log-returns

UK FTSE 100 log-returns

USA S&P 500 log-returns

Source

Yahoo Finance and Investing.com aggregator.

Examples

```
data(g20_returns)
dim(g20_returns); head(g20_returns[, 1:5])
```

`iv_2sls_attribute` *Five-Channel IV/2SLS Channel Attribution for One Bilateral Link*

Description

Estimates the structural equation

$$C_{ij,t} = \alpha + \sum_{c=1}^{5} \theta_c \,\mathrm{Channel}_{c,t} + \gamma_1 f_t + \gamma_2 C_{ij,t-1} + \varepsilon_{ij,t}$$

via two-stage least squares, treating the five channel composites as endogenous and instrumenting them with their own lagged values at $t-5$, $t-10$, $t-15$ plus cross-channel interactions at $t-5$. The first-stage F-statistic per channel, the Sargan over-identification J-test, and the Durbin-Wu-Hausman endogeneity test are reported.

Usage

```
iv_2sls_attribute(C_ij, ch_per, R_full, channel_names = CHN_DEFAULT)
```

Arguments

C_ij	Numeric vector of pairwise daily co-movement (r_i * r_j).
ch_per	A data.frame containing the five channel composites for the current period (with columns named per channel_names).
R_full	Numeric matrix of returns for the period (used to construct the global factor f_t).
channel_names	Character vector of channel column names. Default c("Trade","Financial","Geopolitical","Behav

Value

A list with elements theta (5-vector of structural coefficients), partial_F (per-channel first-stage F-stats), J_stat, J_p, dwh_F, dwh_p, and n_obs; or NULL if the regression cannot be run.

References

Stock, J. H., & Watson, M. W. (2018). Identification and Estimation of Dynamic Causal Effects in Macroeconomics Using External Instruments. Economic Journal, 128(610), 917-948. doi: 10.1111/ecoj.12593.

Mertens, K., & Ravn, M. O. (2013). The Dynamic Effects of Personal and Corporate Income Tax Changes in the United States. American Economic Review, 103(4), 1212-1247. doi: 10.1257/aer.103.4.1212.

Examples

```
d <- load_paper_data()
ch <- build_channel_composites(d$proxies)
p <- period_subset(d$returns, ch, d$periods$GFC)
src <- as.numeric(p$R[, "USA"]); tgt <- as.numeric(p$R[, "SouthKorea"])
fit <- iv_2sls_attribute(src * tgt, p$C, p$R)
fit$theta
```

---

lasso_iv_attribute *LASSO-Based Instrument Selection IV Attribution (Belloni-Chernozhukov-Hansen)*

Description

Estimates the channel-attribution coefficients via post-double-selection LASSO IV with the high-dimensional instrument set. Uses hdm::rlassoIV per channel with controls for the other endogenous regressors. Requires the optional **hdm** package.

Usage

```
lasso_iv_attribute(C_ij, ch_per, R_full, channel_names = CHN_DEFAULT)
```

Arguments

`C_ij`	Numeric vector of pairwise daily co-movement (`r_i * r_j`).
`ch_per`	A data.frame containing the five channel composites for the current period (with columns named per `channel_names`).
`R_full`	Numeric matrix of returns for the period (used to construct the global factor f_t).
`channel_names`	Character vector of channel column names. Default `c("Trade","Financial","Geopolitical","Behav`

Value

A list with elements `theta` and `se`, or `NULL`.

References

Belloni, A., Chernozhukov, V., & Hansen, C. (2014). Inference on Treatment Effects after Selection among High-Dimensional Controls. Review of Economic Studies, 81(2), 608-650. doi: 10.1093/restud/rdt044.

Examples

```
if (requireNamespace("hdm", quietly = TRUE)) {
  d <- load_paper_data()
  ch <- build_channel_composites(d$proxies)
  p <- period_subset(d$returns, ch, d$periods$GFC)
  src <- as.numeric(p$R[, "USA"]); tgt <- as.numeric(p$R[, "SouthKorea"])
  fit <- lasso_iv_attribute(src * tgt, p$C, p$R)
}
```

`load_paper_data` *Load the Paper's Bundled Data*

Description

Convenience loader returning a named list with the three bundled datasets (returns, channel proxies, crisis periods) used in the paper replication.

Usage

```
load_paper_data()
```

Value

A named list with elements `returns`, `proxies`, and `periods`.

Examples

```
d <- load_paper_data(); str(d, max.level = 1)
```

`local_projections` *Local-Projection Channel Attribution at Multiple Horizons*

Description

Estimates horizon-specific impulse responses of the pairwise co-movement to each channel composite at horizons $h \in \{1, 5, 22\}$ days following Jorda (2005). The local projection at horizon h estimates

$$C_{ij,t+h} = \alpha_h + \beta_{c,h}\,\text{Channel}_{c,t} + \text{controls} + u_{ij,t+h}$$

separately for each channel c, with the other four channels and the lagged co-movement and global factor entering as controls.

Usage

```
local_projections(
  C_ij,
  ch_per,
  R_full,
  horizons = c(1, 5, 22),
  channel_names = CHN_DEFAULT
)
```

Arguments

`C_ij`	Numeric vector of pairwise daily co-movement (`r_i * r_j`).
`ch_per`	A data.frame containing the five channel composites for the current period (with columns named per `channel_names`).
`R_full`	Numeric matrix of returns for the period (used to construct the global factor f_t).
`horizons`	Integer vector of horizons. Default `c(1, 5, 22)`.
`channel_names`	Character vector of channel column names. Default `c("Trade","Financial","Geopolitical","Behav`

Value

A list with one element per horizon; each element is a length-`length(channel_names)` numeric vector of LP coefficients.

References

Jorda, O. (2005). Estimation and Inference of Impulse Responses by Local Projections. American Economic Review, 95(1), 161-182. doi: 10.1257/0002828053828518.

Plagborg-Moller, M., & Wolf, C. K. (2021). Local Projections and VARs Estimate the Same Impulse Responses. Econometrica, 89(2), 955-980. doi: 10.3982/ECTA17813.

Examples

```
d <- load_paper_data()
ch <- build_channel_composites(d$proxies)
p <- period_subset(d$returns, ch, d$periods$GFC)
src <- as.numeric(p$R[, "USA"]); tgt <- as.numeric(p$R[, "SouthKorea"])
lp <- local_projections(src * tgt, p$C, p$R)
```

`modwt_detail` *MODWT Wavelet Detail at a Specified Scale*

Description

Returns the MODWT detail coefficients of a return series at the specified scale, using the Daubechies least-asymmetric filter of length 8 (LA8). The maximal-overlap discrete wavelet transform is shift-invariant and aligned with the original time-axis, making it suited to financial returns; see Percival and Walden (2000).

Usage

```
modwt_detail(x, scale = 5, J = 6, filter = "la8")
```

Arguments

`x`	Numeric vector of returns.
`scale`	Integer scale (1-6) corresponding to dyadic horizons of $[2^s, 2^{s+1}]$ trading days. Default 5 (32-64 day horizon).
`J`	Integer maximum decomposition level. Default 6.
`filter`	Character; the wavelet filter family to use. Default `"la8"` for the LA8 filter. See `modwt`.

Value

Numeric vector of detail coefficients at scale `scale`.

References

Percival, D. B., & Walden, A. T. (2000). *Wavelet Methods for Time Series Analysis*. Cambridge University Press.

Examples

```
x <- rnorm(512)
d5 <- modwt_detail(x, scale = 5)
length(d5)
```

network_summary *Summary Statistics of a Contagion Network*

Description

Returns a list of standard centrality and density statistics for a directed contagion network.

Usage

```
network_summary(g)
```

Arguments

g	An igraph object.

Value

A list with elements n_edges, density, in_degree, out_degree, betweenness, and eigenvector.

Examples

```
m <- matrix(runif(25, 0, 0.1), 5, 5); diag(m) <- 0
g <- build_network(m, threshold = 0.05)
network_summary(g)$density
```

orthogonalise_residual *Orthogonalise One Series Against Another*

Description

Returns the residuals from a regression of y on x; the residual is by construction orthogonal to x in the sample. This is the pre-processing step used to construct the behavioural channel composite, which is orthogonalised against the financial composite to avoid the within-VIX decomposition that contaminates cross-channel identification when both composites share VIX-derivative inputs.

Usage

```
orthogonalise_residual(y, x)
```

Arguments

y	Numeric vector to be orthogonalised.
x	Numeric vector against which y is orthogonalised.

Value

Numeric vector of length `length(y)` containing the residuals.

Examples

```
a <- rnorm(100); b <- 0.5 * a + rnorm(100); cor(a, orthogonalise_residual(b, a))
```

---

period_subset — *Subset a Returns and Channel Panel by Period*

Description

Selects the rows of an xts returns object and the matching rows of a channel-composite data.frame that fall within a date range.

Usage

```
period_subset(returns_xts, channels_df, period_dates)
```

Arguments

`returns_xts`	An xts object of daily returns indexed by Date.
`channels_df`	A data.frame with a `Date` column matching the index of `returns_xts`.
`period_dates`	A character or Date vector of length 2 `c(start, end)`.

Value

A list with elements `R` (xts subset) and `C` (data.frame subset).

Examples

```
d <- load_paper_data()
ch <- build_channel_composites(d$proxies)
p <- period_subset(d$returns, ch, c("2008-01-01","2008-12-31"))
nrow(p$C)
```

plot_attribution_evolution

Evolution-of-Shares Line Plot

Description

Line plot of channel-attribution share evolution across crisis sub-periods.

Usage

```
plot_attribution_evolution(period_shares)
```

Arguments

period_shares	Per-period share data.frame (output from run_contagion_pipeline).

Value

A ggplot object.

plot_attribution_stack

Stacked Bar Plot of Channel-Attribution Shares

Description

Draws a stacked bar chart of channel-attribution shares across crisis sub-periods. Returns a ggplot if **ggplot2** is available, else uses base barplot.

Usage

```
plot_attribution_stack(period_shares, ...)
```

Arguments

period_shares	A data.frame with columns Period, Trade, Financial, Geopolitical, Behavioral, Monetary.
...	Additional arguments passed to ggplot2::ggsave or to barplot.

Value

A ggplot object (or invisibly the matrix used for base plotting).

Examples

```
d <- load_paper_data()
ch <- build_channel_composites(d$proxies)
res <- run_contagion_pipeline(d$returns, ch, d$periods, n_cores = 2)
plot_attribution_stack(res$period_shares)
```

`plot_qte_intensity` *Two-Panel QTE Intensity Plot*

Description

Top panel: mean QTE per sub-period. Bottom panel: network density per sub-period.

Usage

```
plot_qte_intensity(stage1_summary)
```

Arguments

`stage1_summary`	A data.frame with columns `Period`, `MeanQTE`, `Density`.

Value

A patchwork ggplot if available, else a multi-panel base plot.

`plot_robustness_value` *Robustness-Value Heatmap*

Description

Heatmap of Cinelli-Hazlett robustness values per channel and sub-period.

Usage

```
plot_robustness_value(rv_matrix)
```

Arguments

`rv_matrix`	Numeric matrix with rownames = periods, colnames = channels.

Value

A ggplot object.

qte_pair *Pairwise Wavelet-Quantile Transfer Entropy*

Description

Estimates the directional information flow from one wavelet-detail series x to another y at the specified quantile, following the quantile-regression-based transfer-entropy estimator. A positive value indicates that conditioning on the past of x improves the conditional-quantile prediction of y beyond what y's own past supplies.

Usage

```
qte_pair(x, y, tau = 0.5)
```

Arguments

x	Numeric source series (typically a MODWT detail coefficient).
y	Numeric target series (typically a MODWT detail coefficient).
tau	Quantile level in (0,1). Default 0.50 (median).

Value

A scalar; NA if there are insufficient observations or the quantile regressions fail to converge.

References

Schreiber, T. (2000). Measuring Information Transfer. Physical Review Letters, 85(2), 461. doi: 10.1103/PhysRevLett.85.461.

Han, H., Linton, O., Oka, T., & Whang, Y.-J. (2016). The Cross- Quantilogram. Journal of Econometrics, 193(1), 251-270. doi: 10.1016/j.jeconom.2016.03.001.

Examples

```
x <- rnorm(500); y <- 0.3 * c(0, x[-500]) + rnorm(500)
qte_pair(x, y, tau = 0.5)
```

rigobon_id *Heteroskedasticity-Based Identification (Rigobon 2003)*

Description

Identifies the channel-attribution coefficients by exploiting regime shifts in the variance of returns within the period. Useful when the Sargan over-identification test rejects the joint validity of external instruments and an alternative identification strategy is required.

Usage

```
rigobon_id(C_ij, ch_per, R_full, channel_names = CHN_DEFAULT)
```

Arguments

C_ij	Numeric vector of pairwise daily co-movement (r_i * r_j).
ch_per	A data.frame containing the five channel composites for the current period (with columns named per channel_names).
R_full	Numeric matrix of returns for the period (used to construct the global factor f_t).
channel_names	Character vector of channel column names. Default c("Trade","Financial","Geopolitical","Behav

Value

A list with element theta: a length-five numeric vector of structural coefficients, or NULL.

References

Rigobon, R. (2003). Identification through Heteroskedasticity. Review of Economics and Statistics, 85(4), 777-792. doi: 10.1162/003465303772815727.

Examples

```
d <- load_paper_data()
ch <- build_channel_composites(d$proxies)
p <- period_subset(d$returns, ch, d$periods$GFC)
src <- as.numeric(p$R[, "USA"]); tgt <- as.numeric(p$R[, "SouthKorea"])
rig <- rigobon_id(src * tgt, p$C, p$R)
```

run_contagion_pipeline   *End-to-End Contagion-Channel Pipeline*

Description

Runs the full two-stage detection-and-attribution pipeline over a specified set of crisis sub-periods: Stage 1 produces a per-period WQTE flow matrix at the supplied scale and quantile, and Stage 2 attributes each significant link to one of five channels via IV/2SLS. Network density, top transmitter/receiver, and per-period channel-attribution shares are returned in a list.

Usage

```
run_contagion_pipeline(
  returns,
  channels,
  periods,
  scale = 5,
  tau = 0.5,
  threshold_period = names(periods)[1],
  edge_quantile = 0.75,
  n_cores = 2L
)
```

Arguments

`returns`	An xts of daily returns indexed by date.
`channels`	A data.frame of channel composites (output of `build_channel_composites`).
`periods`	A named list of length-2 character or Date vectors specifying `c(start_date, end_date)` for each sub-period.
`scale`	Integer wavelet scale. Default 5.
`tau`	Quantile level. Default 0.50.
`threshold_period`	Name of the period in `periods` from which the Pre-Crisis-baseline absolute threshold is computed. Default `names(periods)[1]`.
`edge_quantile`	Numeric in (0,1); the quantile of positive WQTE in the threshold period used as the absolute threshold. Default 0.75.
`n_cores`	Integer number of parallel cores. Default `2L` per CRAN policy; raise this for production-scale runs.

Value

A list with elements

stage1 Per-period list with `F` (flow matrix), `network`, and `summary`.

stage2 Per-period list of attribution data.frames with one row per significant link.

period_shares Per-period mean attribution-share data.frame.

threshold The absolute WQTE threshold used.

Examples

```
d <- load_paper_data()
ch <- build_channel_composites(d$proxies)
res <- run_contagion_pipeline(d$returns, ch, d$periods, n_cores = 2)
res$period_shares
```

---

walktrap_communities *Walktrap Community Detection on a Contagion Network*

Description

Detects communities using the Walktrap algorithm of Pons and Latapy (2006) on the symmetrised version of the directed contagion network.

Usage

```
walktrap_communities(g)
```

Arguments

g	An igraph object.

Value

An integer vector of community memberships, one per vertex; or `NULL` if the network has too few edges.

Examples

```
m <- matrix(runif(25, 0, 0.1), 5, 5); diag(m) <- 0
g <- build_network(m, threshold = 0.02)
walktrap_communities(g)
```

zscore *Z-score Standardisation*

Description

Returns the z-score of a numeric vector, robust to NAs and zero-variance input.

Usage

```
zscore(x)
```

Arguments

`x`	Numeric vector.

Value

Numeric vector of the same length as `x` with mean zero and unit standard deviation; returns a zero vector if the input has no finite variation.

Examples

```
zscore(rnorm(100))
```

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