

RESEARCH INSIGHT

When shock transmission rotates

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Executive summary



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Aggregate connectedness can hide a changing transmission structure.

Key findings

- Aggregate connectedness looks similar across quantiles.
- Sector transmission roles change as drawdowns deepen.
- Industrials strengthen while Technology weakens in deep drawdowns.

Key metrics

Drawdown regimes	4
Deep drawdowns examined	4
Industrials calm tail shift	-3.57
Industrials >20% tail shift	+1.70
Technology calm tail shift	+1.22
Technology >20% tail shift	-1.63
Largest deep-drawdown event shift	Energy, +15.69 in 2020

Why it matters

Aggregate connectedness can hide important changes underneath. The level of transmission matters. So does where it comes from.

Aggregate connectedness hides what changes underneath

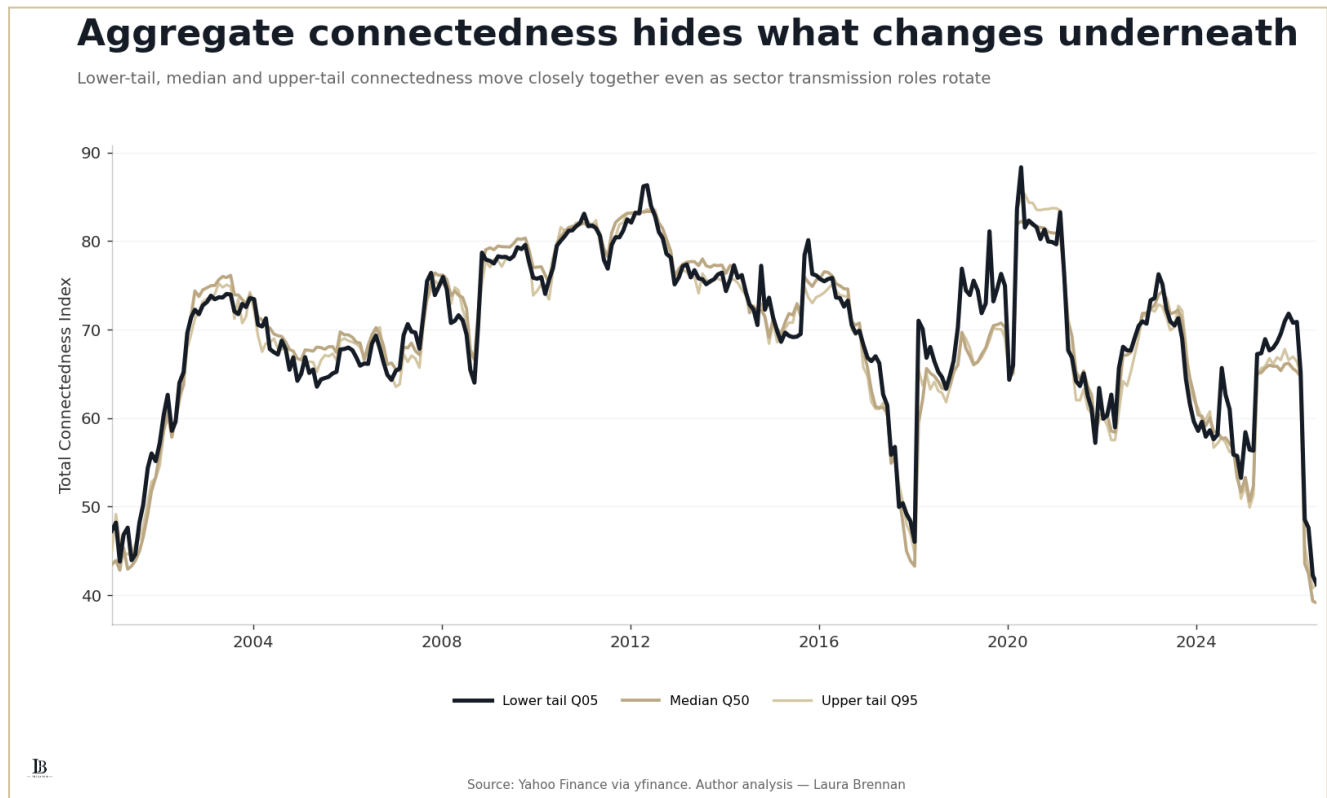


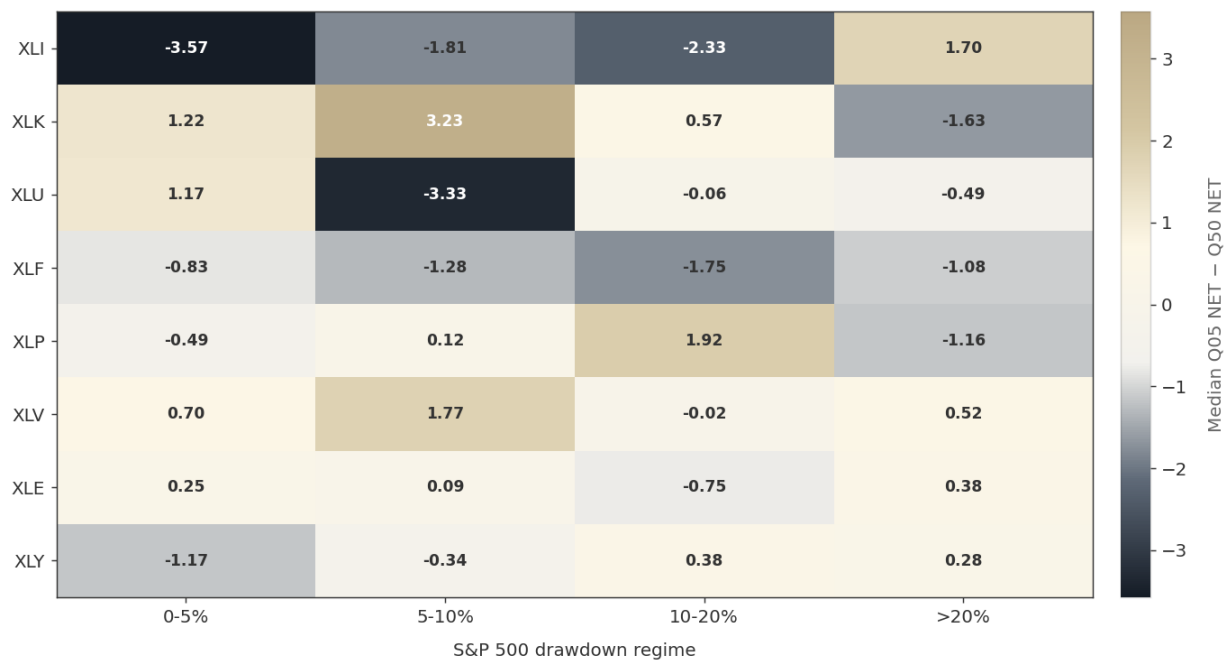
Figure 1. Total connectedness across lower-tail, median and upper-tail quantiles.

Lower-tail, median and upper-tail total connectedness follow remarkably similar paths through time. Major increases and declines in aggregate connectedness generally occur across all three states together, with relatively modest separation between the series. At the system level, this can make downside transmission appear similar to ordinary market transmission. That interpretation is incomplete. The aggregate index measures the overall intensity of cross-sector transmission. It does not show whether the **same sectors are transmitting and receiving those shocks** in each state. A relatively stable aggregate relationship can therefore coexist with substantial changes in the network underneath. This distinction motivates the rest of the analysis: rather than asking only whether connectedness changes during drawdowns, the relevant question becomes **who carries the shock when market conditions deteriorate?**

Sector transmission changes as drawdowns deepen

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The aggregate network remains connected, but individual sectors shift between stronger and weaker downside transmission roles



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Source: Yahoo Finance via yfinance. Author analysis — Laura Brennan

Figure 2. Median lower-tail transmission shift across S&P 500 drawdown regimes.

Sector roles change progressively across drawdown regimes. The difference between lower-tail and median transmission is not uniform across sectors, and the direction of that difference can reverse as losses deepen. Industrials provide the clearest example. Their median tail shift moves from **-3.57 in 0-5% drawdowns to +1.70 when drawdowns exceed 20%**. Technology moves in the opposite direction. Its tail shift changes from **+1.22 in calm conditions to -1.63 in the deepest regime**. Other sectors show smaller or less monotonic changes. Financials remain negative across all four regimes, while Healthcare stays mostly positive. Consumer Staples shift towards stronger downside transmission in the 10-20% regime before weakening again beyond 20%. The result is not simple convergence. **Drawdowns reorganise the relative transmission roles inside the network.**

Industrials and Technology shift in opposite directions

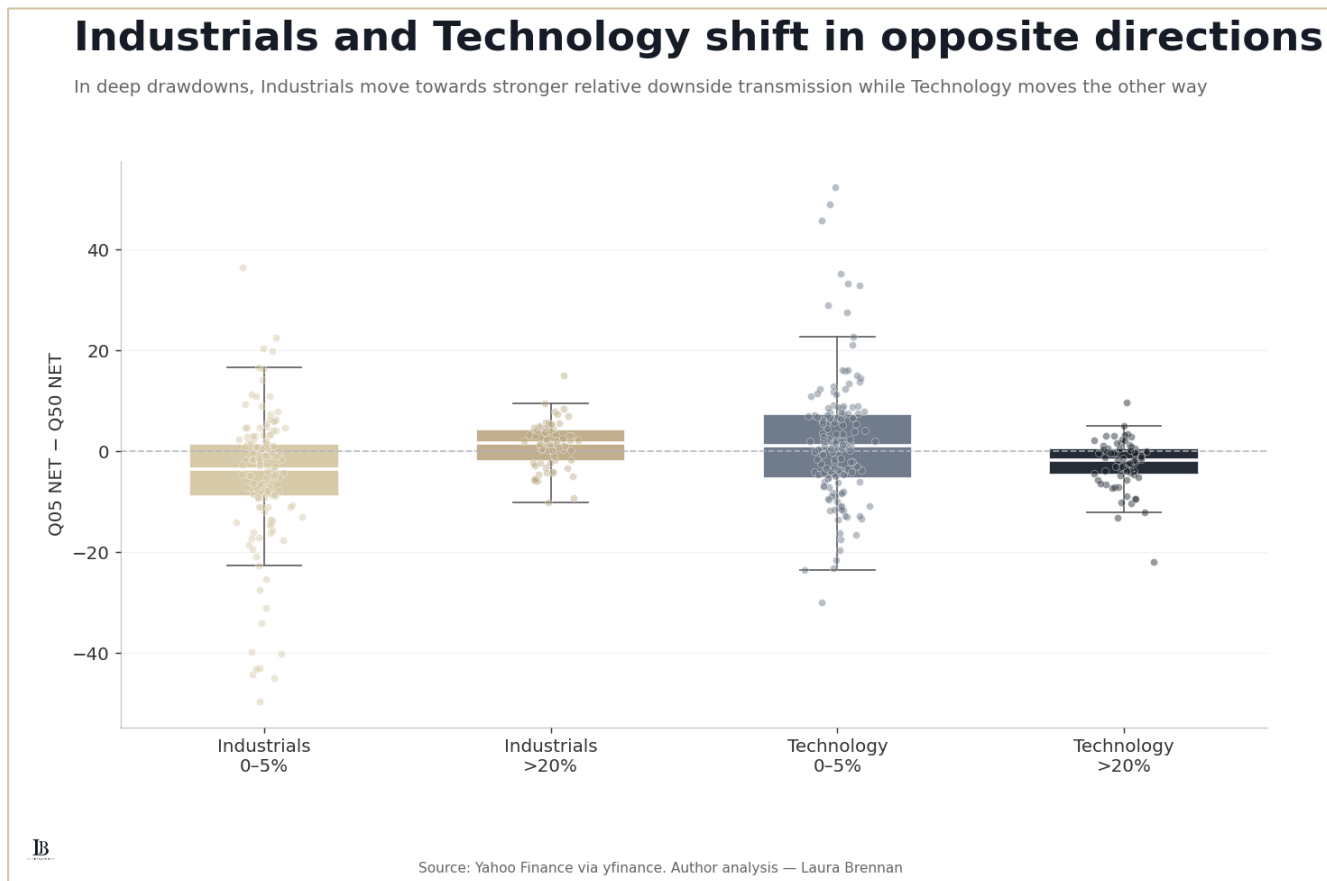


Figure 3. Distribution of lower-tail transmission shifts for Industrials and Technology in calm and >20% drawdowns.

The opposing movement in Industrials and Technology is visible not only in their median values but in the underlying distributions. During 0–5% drawdowns, Industrials have a median tail shift of **-3.57**, indicating a weaker lower-tail transmission role relative to their median-state behaviour. During >20% drawdowns, the median moves to **+1.70**. Technology follows the reverse pattern. Its median moves from **+1.22** in calm conditions to **-1.63** once the drawdown exceeds 20%. The distributions remain wide, particularly in calm conditions, so neither sector occupies a fixed role at every point in time. But their central tendencies move in opposite directions as market losses become severe. This is important because stress does not simply make every sector a stronger transmitter. **It changes which sectors become relatively more important to the transmission process.**

Shock transmission rotates in deep drawdowns

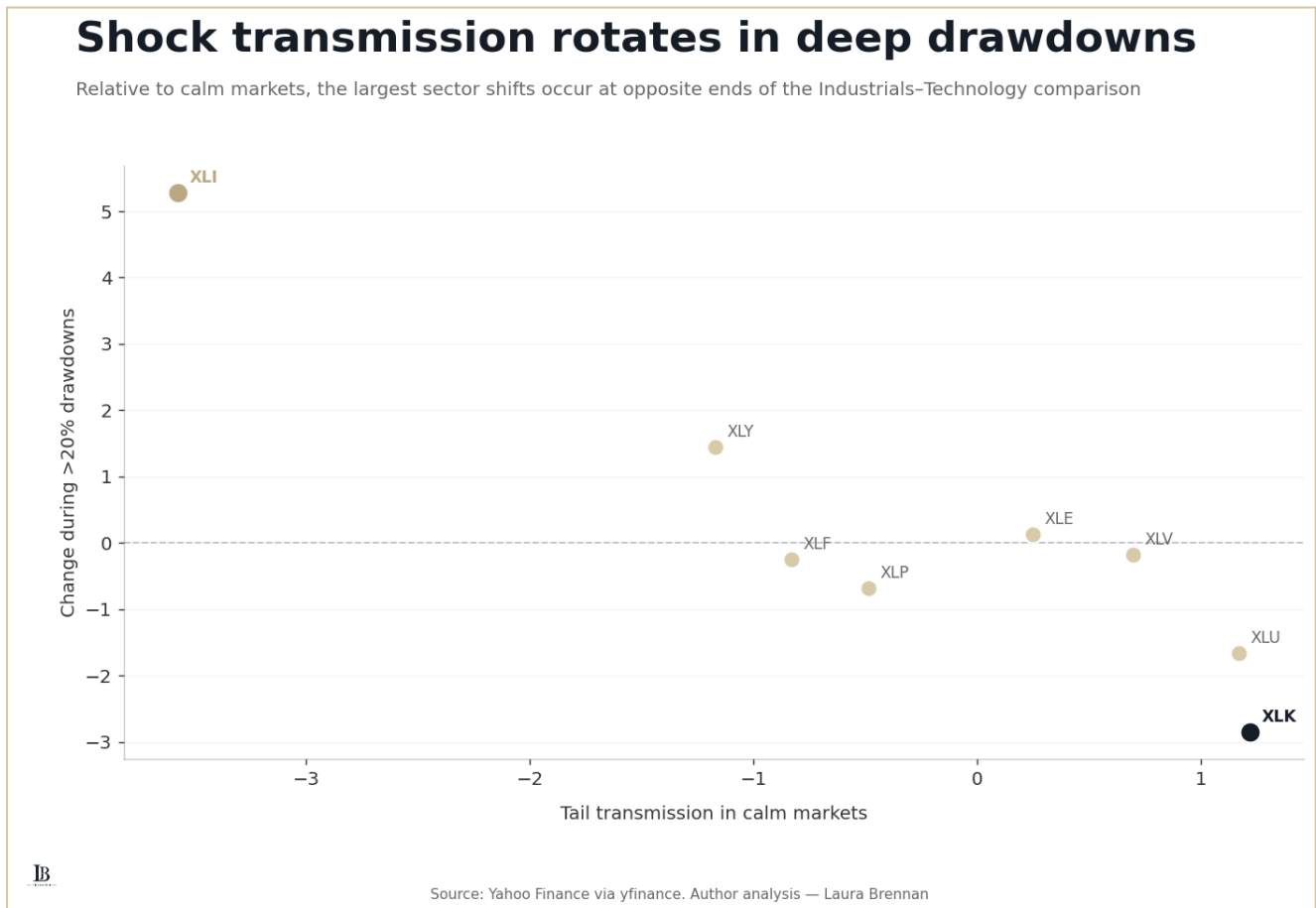


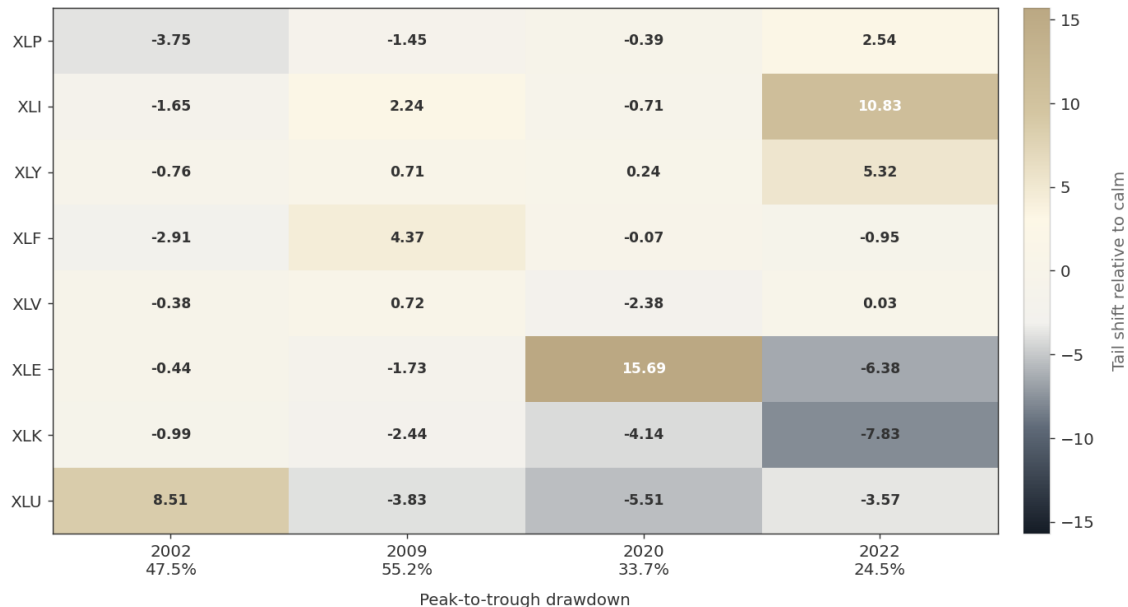
Figure 4. Change in median tail transmission between 0–5% and >20% S&P 500 drawdowns.

The cross-sector comparison makes the rotation more explicit. Industrials show the largest positive change between calm and severe drawdowns, increasing by approximately **5.27 points**. Consumer Discretionary also moves towards stronger relative downside transmission. Technology shows the largest negative change, falling by approximately **2.85 points**, followed by Utilities. Several other sectors remain closer to zero, suggesting comparatively smaller changes in their relative transmission role. The important feature is the dispersion across sectors. A deep drawdown does not push every part of the network in the same direction. Some sectors become more important transmission channels while others recede. **System-wide stress therefore changes the composition of the network, not merely its overall intensity.**

Each deep drawdown has a different transmission structure

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The sectors carrying downside shocks rotate across the 2002, 2009, 2020 and 2022 peak-to-trough declines



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Source: Yahoo Finance via yfinance. Author analysis — Laura Brennan

Figure 5. Sector tail shifts across major peak-to-trough drawdowns.

The composition of downside transmission also changes substantially from one major drawdown to another. In the 2002 decline, Utilities show the strongest positive tail shift at **+8.51**, while most other sectors remain negative. The 2009 drawdown has a different structure, with Financials moving to **+4.37** and Industrials to **+2.24**. During the 2020 drawdown, Energy becomes the dominant positive shift at **+15.69**, while Utilities, Technology and Healthcare move in the opposite direction. The 2022 decline rotates again. Industrials rise sharply to **+10.83**, Consumer Discretionary reaches **+5.32**, while Energy falls to **-6.38** and Technology to **-7.83**. The largest drawdowns therefore do not share a fixed sector transmission hierarchy. **Stress repeats. Its transmission structure does not.**

Technology's relative downside transmission role falls

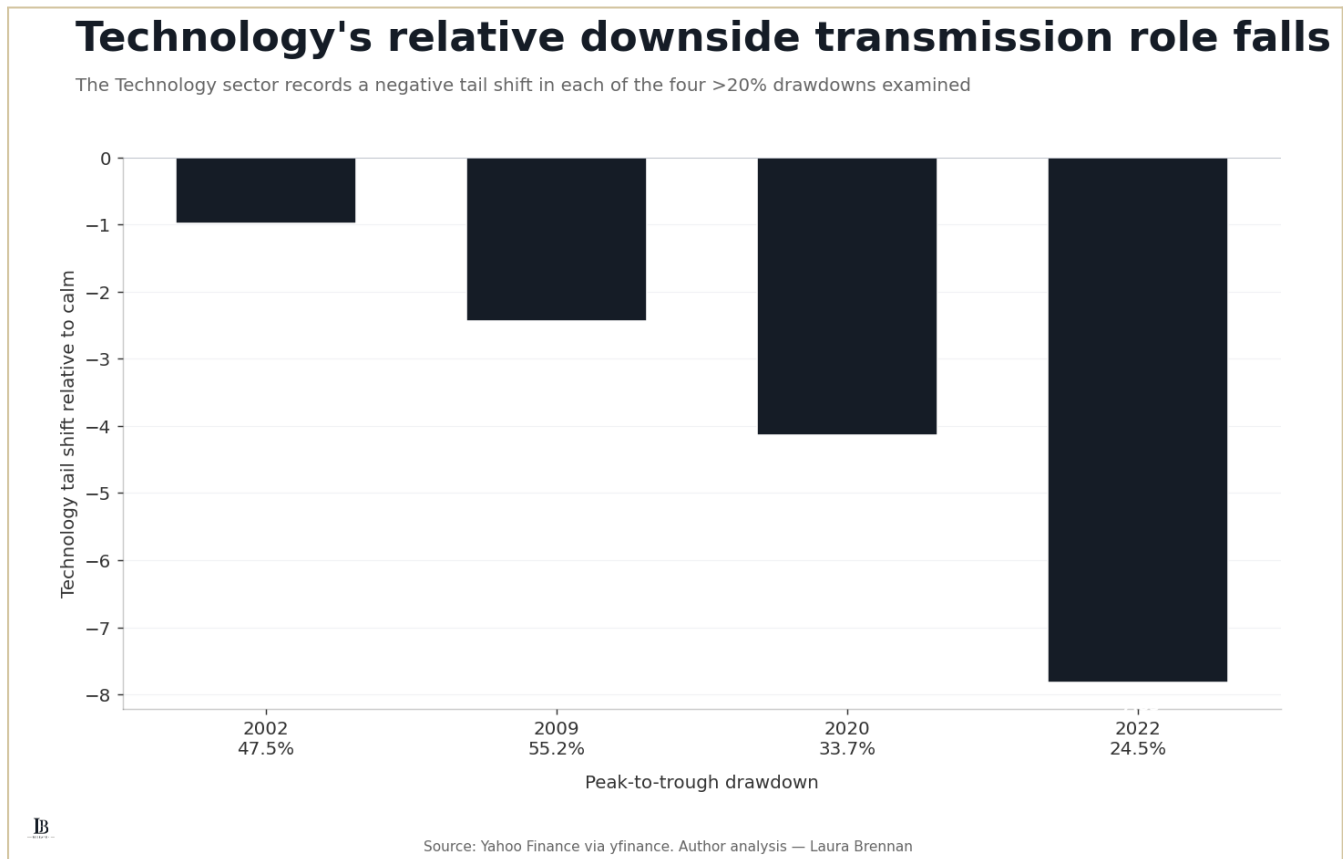


Figure 6. Technology tail shift across major >20% peak-to-trough drawdowns.

Technology records a negative tail shift in each of the four major drawdowns examined. The magnitude becomes progressively larger across the events shown, moving from approximately **-0.99 in 2002** to **-2.44 in 2009**, **-4.14 in 2020** and **-7.83 in 2022**. This should not be interpreted as Technology becoming unimportant during market stress. The measure is relative: it compares the sector's lower-tail network role with its role under the median state. The finding therefore suggests that Technology's **relative contribution to downside transmission weakens**, even when the sector itself may remain highly exposed to the broader market shock. That distinction is important. Large losses and systemic transmission are related concepts, but they are not the same thing.

Methodology

Data

Sample period

2000–7 August 2026

Universe

- XLE Energy
- XLF Financials
- XLI Industrials
- XLK Technology
- XLP Consumer Staples
- XLU Utilities
- XLV Healthcare
- XLY Consumer Discretionary
- SPY used for S&P 500 drawdown measurement

Data source

Yahoo Finance via yfinance. Daily auto-adjusted closing prices.

Measures

Quantile VAR

Sector return dynamics are estimated using quantile vector autoregressions at:

- Q05, lower-tail state
- Q50, median state
- Q95, upper-tail state

This allows the transmission structure to vary across different parts of the conditional return distribution rather than imposing a single average relationship.

Total connectedness index

Forecast-error variance decomposition is used to measure the share of forecast uncertainty attributable to shocks originating in other sectors.

The total connectedness index summarises the aggregate level of cross-sector transmission.

Net transmission

For each sector:

NET = shocks transmitted TO others – shocks received FROM others

Positive values indicate a net transmitter.

Negative values indicate a net receiver.

Tail shift

The central measure for this report is:

Q05 NET – Q50 NET

Positive values indicate that a sector becomes relatively more important as a transmitter in the downside tail.

Negative values indicate that its relative transmission role weakens.

Drawdown design

S&P 500 drawdown is measured relative to the preceding market peak.

For the regime analysis:

- 0–5%
- 5–10%
- 10–20%
- >20%

For the event analysis, major episodes are defined using true peak-to-trough drawdown cycles rather than individual observations within an ongoing decline.

The four >20% events retained with sufficient QVAR observations are:

Trough	Maximum drawdown
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2002	47.5%
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2009	55.2%
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2020	33.7%
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2022	24.5%
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Research workflow

Step	Description
Data	Daily SPY and sector ETF prices
Returns	Daily sector returns
State model	Quantile VAR at Q05, Q50 and Q95
Network measure	Generalised FEVD connectedness
Sector measure	Net directional connectedness
Tail measure	Q05 NET – Q50 NET
Drawdown measure	S&P 500 peak-to-trough decline
Regimes	0–5%, 5–10%, 10–20%, >20%
Event test	Major >20% peak-to-trough cycles
Interpretation	Change in sector transmission relative to ordinary market condition

Research implications

Connectedness alone does not describe the full network

The results suggest that aggregate connectedness and transmission composition capture different dimensions of systemic structure.

Key observations

- Aggregate connectedness across Q05, Q50 and Q95 follows broadly similar long-run dynamics.
- Sector-level tail transmission varies materially across drawdown regimes.
- Some sectors change from relatively weaker to stronger downside transmitters as losses deepen.
- Industrials and Technology show particularly clear opposing changes.
- Major historical drawdowns exhibit different sector transmission structures.
- No single sector hierarchy characterises all severe market declines.
- Technology's relative downside transmission role is negative across all four >20% events examined.

Together, these results suggest that monitoring only the total level of connectedness can conceal important changes beneath the surface.

Two periods may display similar system-wide connectedness while presenting quite different **sources and pathways of shock transmission**.

For portfolio and systemic-risk analysis, the relevant question is therefore not simply:

How connected is the market?

It is also:

Where is that connectedness coming from?

References

Data

Yahoo Finance, accessed through yfinance.

SPDR sector ETFs: XLE, XLF, XLI, XLK, XLP, XLU, XLV and XLY.

SPDR S&P 500 ETF Trust, SPY.

Data through 7 August 2026.

Methodology

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White, H., Kim, T.-H. and Manganelli, S. (2015). “VAR for VaR: Measuring Tail Dependence Using Multivariate Regression Quantiles.” *Journal of Econometrics*, 187(1), 169–188.

Diebold, F. X. and Yilmaz, K. (2012). “Better to Give than to Receive: Predictive Directional Measurement of Volatility Spillovers.” *International Journal of Forecasting*, 28(1), 57–66.

Software

Python, pandas, NumPy, statsmodels, SciPy, matplotlib and yfinance. The yfinance package provides programmatic access to Yahoo Finance market data.

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