Crowded Trades:

Implications for Sector Rotation and Factor Timing

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Our Goal

Our goal is to demonstrate how to locate bubbles and to determine whether they are inflating or deflating, for the purpose of generating excess returns.

Our Approach

We use a measure of centrality as a proxy for crowded trading to locate bubbles, and we use a measure of relative value to distinguish a bubble's run-up from its sell-off.

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Centrality – Step 1

The Absorption Ratio

- The absorption ratio quantifies the level of concentration among a group of assets.
- The absorption ratio is equal to the proportion of variation in asset returns that is explained or “absorbed” by a fixed number of factors in a principal components analysis.
- When the absorption ratio is elevated, shocks tend to propagate quickly and broadly.

$$AR = \frac{\sum_{i=1}^{n} \sigma_{E_i}^2}{\sum_{j=1}^{N} \sigma_{A_j}^2}$$

AR: absorption ratio

N: number of assets

n: number of eigenvectors used to calculate AR

$\sigma_{E_i}^2$: variance of the *i*-th eigenvector

$\sigma_{A_j}^2$: variance of the *j*-th asset

For details, see: Kritzman, M., Y. Li, S. Page and R. Rigobon. 2011. “Principal Components as a Measure of Systemic Risk.” Journal of Portfolio Management.

Centrality – Step 2

- Centrality captures the extent to which a group of similar assets drives the variability of returns across a broader universe.

- Centrality is higher to the extent:
  - An asset is relatively more volatile
  - An asset is connected to other assets

$$C_i = \frac{\sum_{j=1}^{n} \left(AR^j \cdot \left| w_i^j \right| \right)}{\sum_{j=1}^{n} AR^j}$$

C_i = centrality of asset *i*

AR^j = absorption ratio of the *j*-th eigenvector

w_i^j = weight of *i*-th asset within *j*-th eigenvector

n = number of eigenvectors used to compute AR

For details, see: Kinlaw, W., M. Kritzman and D. Turkington. 2012. “Toward Determining Systemic Importance.” Journal of Portfolio Management.

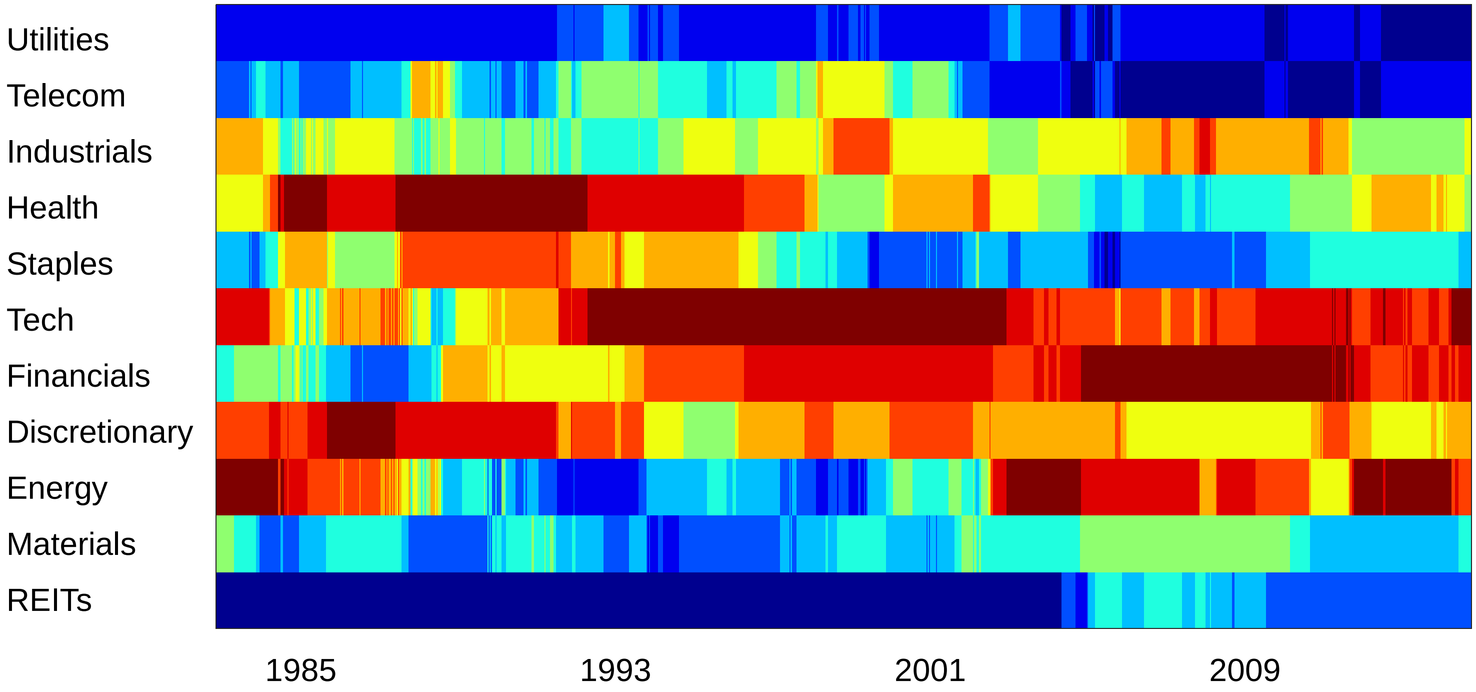
Why is Centrality Indicative of Crowded Trading?

- Centrality is higher for groups that are relatively more volatile and for groups that are more connected to other groups.
- Crowded trading leads to large order imbalances which result in large price adjustments and greater volatility.
- Crowding into a group raises the correlation among the companies within the group, which raises the group's volatility.
- Investors crowd toward groups that are bellwethers, which tend to drive the behavior of other groups, thus raising the connectivity of the bellwether group.

Sector Centrality

- To measure sector centrality, we obtain two years of historical daily sector returns.
- We weight each sector's historical returns by the square root of its market capitalization weights because larger sectors are relatively more important than smaller sectors.
- We apply an exponential time decay with a half-life of one year to emphasize recent data and to allow the impact of historical events to recede gradually over time.
- We estimate the covariance matrix across sectors and compute centrality using the top two eigenvectors.

Evidence of Centrality and Crowded Trading



Heat map shows cross-sectional percent ranks of sector centrality scores through time; blue indicates a low centrality score and red indicates a high centrality score. Prior to computing the scores, we weight each sector's returns by the square root of its market value. We then compute the centrality score for each sector using a two-year lookback window, a one-year half life for the exponential decay, and the top two eigenvectors (n = 2). Results span 1984 to 2017. Source: State Street Global Exchange.

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Sector Relative Value

- To determine the relative value of a sector, we first compute its price to book value ratio.

- We normalize each sector's valuation by dividing it by its own 10-year average, to account for the fact that some sectors have consistently higher valuations than other sectors.

- Finally, we divide each sector's normalized valuation by the average of the normalized valuations of all the other sectors to arrive at a cross-sectional measure of relative value.

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Centrality Combined with Relative Value

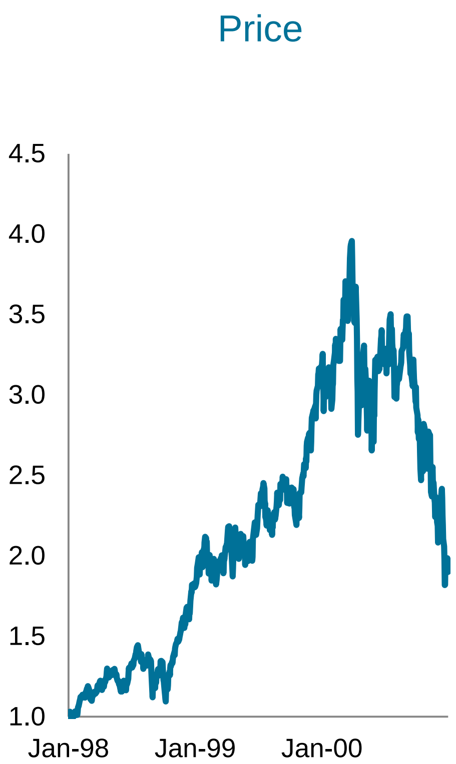
- Centrality is helpful for locating bubbles, but it cannot distinguish a bubble’s run-up from its sell-off.

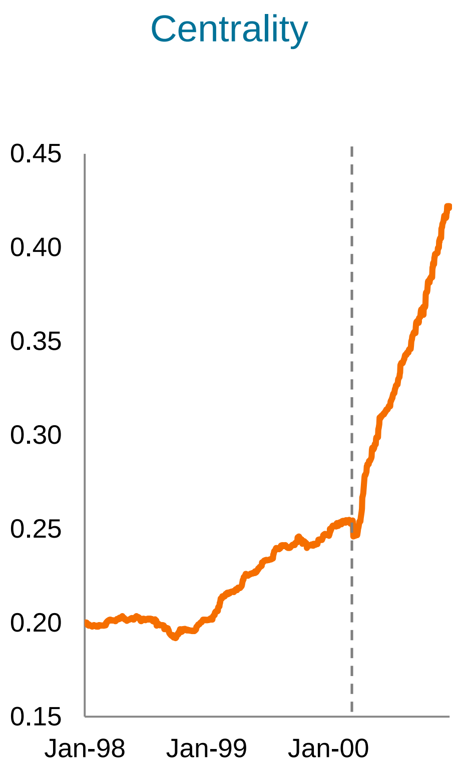
- Relative value is helpful for distinguishing a bubble’s run-up from its sell-off, but it cannot locate bubbles because it fails to distinguish price changes that occur in response to changes in fundamental value from those that result from a shift in investor psychology.

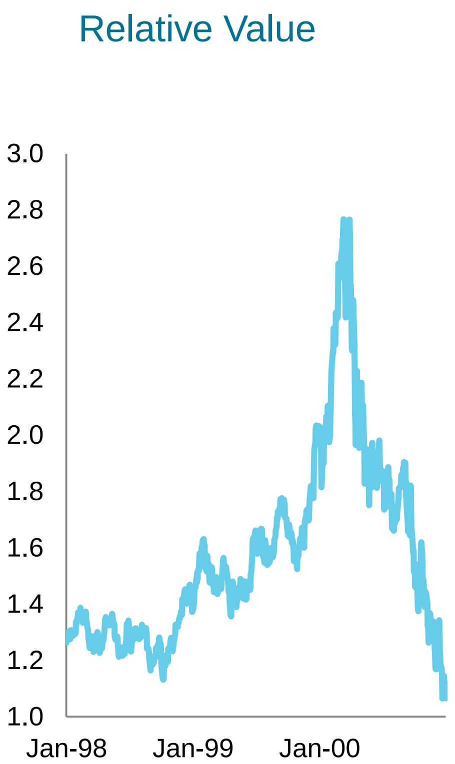
- In *combination*, however, they are very effective at locating bubbles and separating their run-up from their sell-off.

Centrality Combined with Relative Value

The Tech Bubble (1998-2000)



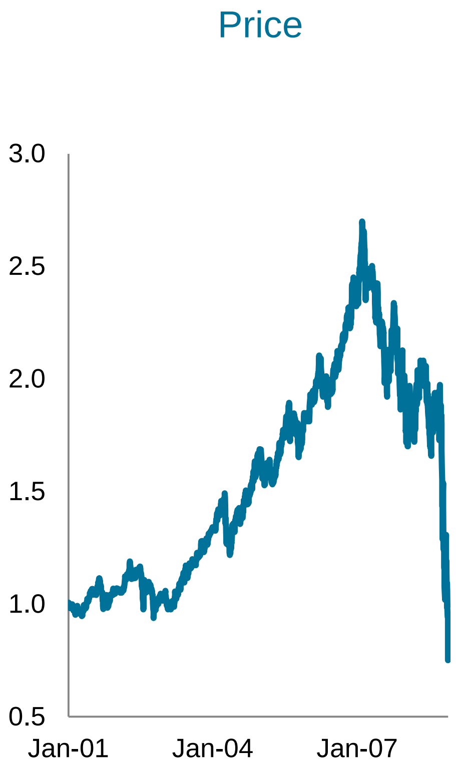


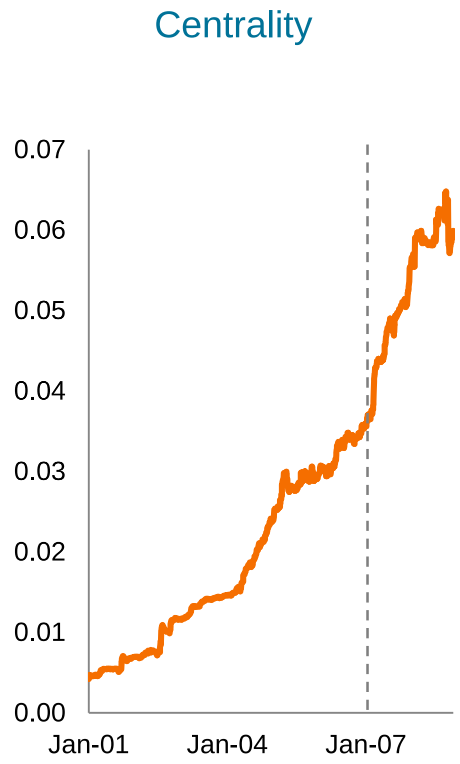


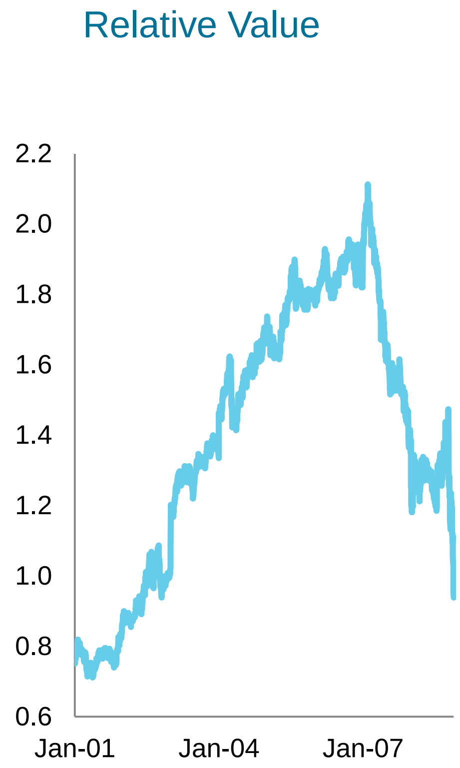
Centrality for the U.S. Technology sector is computed across a universe of 11 U.S. sector indices from DataStream. Source: DataStream, State Street Global Exchange.

Centrality Combined with Relative Value

The Housing Bubble (2001-2008)







Centrality for the U.S. REITs sector is computed across a universe of 11 U.S. sector indices from DataStream. Source: DataStream, State Street Global Exchange.

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Challenge: Thresholds Are Not Uniform Across Bubbles

To address this issue, we:

- Focus on the change in centrality, measured as a standardized shift.
- Compare centrality and relative value cross-sectionally.

Conditional Sector Performance

Methodology:

1. Rank all sectors by their centrality and relative value scores.
2. Identify the sectors that rank in the top three by both measures.
3. Form portfolios for four combinations of crowding and relative value.
4. Impose a one day implementation lag and record the next day's portfolio return.
5. Move to the next day and repeat.

Conditional Sector Performance Relative to S&P 500

	Not Crowded	Crowded
Not Overvalued	No Bubble	Bubble Run Up*
Overvalued	No Bubble	Bubble Sell Off

* Filtered for sectors that have experienced an increase in price over the prior year.

Numbers in italics are risk-adjusted returns. See preceding methodology slide for details. Results span 1985 to 2017. Source: DataStream, State Street Global Exchange.

Conditional Sector Performance Relative to S&P 500

	Not Crowded	Crowded
Not Overvalued	No Bubble 0.3% *0.05*	Bubble Run Up* **6.7%** ***0.70***
Overvalued	No Bubble 0.6% *0.07*	Bubble Sell Off **-6.5%** ***-0.50***

* Filtered for sectors that have experienced an increase in price over the prior year.

Numbers in italics are risk-adjusted returns. See preceding methodology slide for details. Results span 1985 to 2017. Source: DataStream, State Street Global Exchange.

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Sector Rotation Backtest

Methodology:

1. Assign expected returns of +5% to sectors identified as run ups, –5% to sectors identified as sell offs, and zero otherwise.

2. Compute a covariance matrix from the prior five years of returns.

3. Set risk aversion equal to one, and solve for the mean variance optimal allocation with long only weights that sum to one.

4. After a one day implementation lag, invest in a portfolio equal to the average optimal weights over the previous quarter (to control turnover).

5. Move to the next day and repeat.

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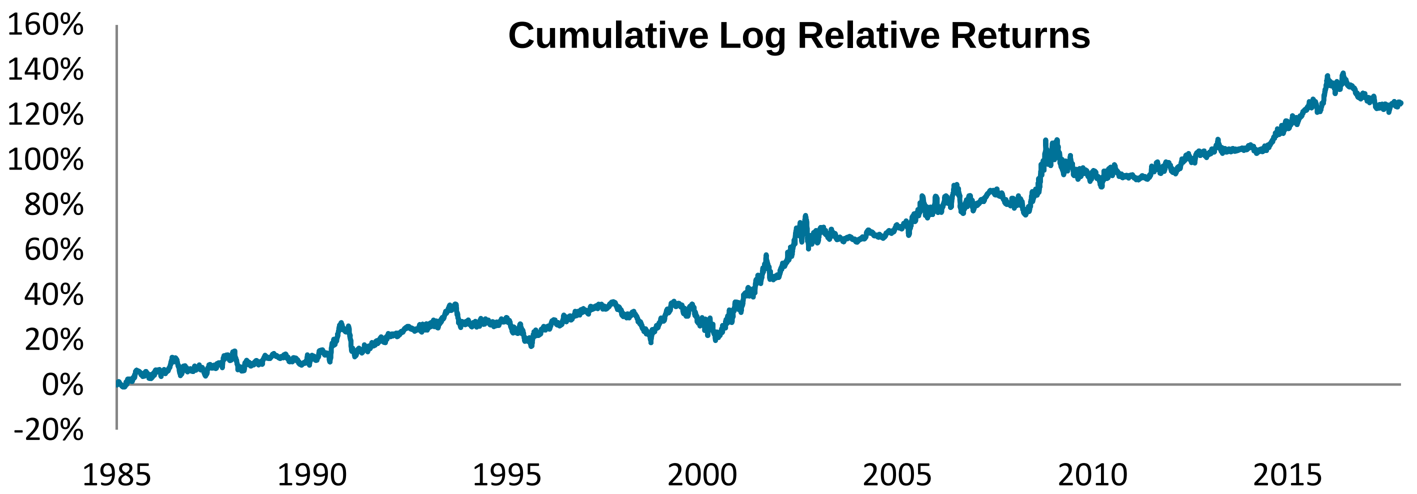
Sector Rotation Backtest

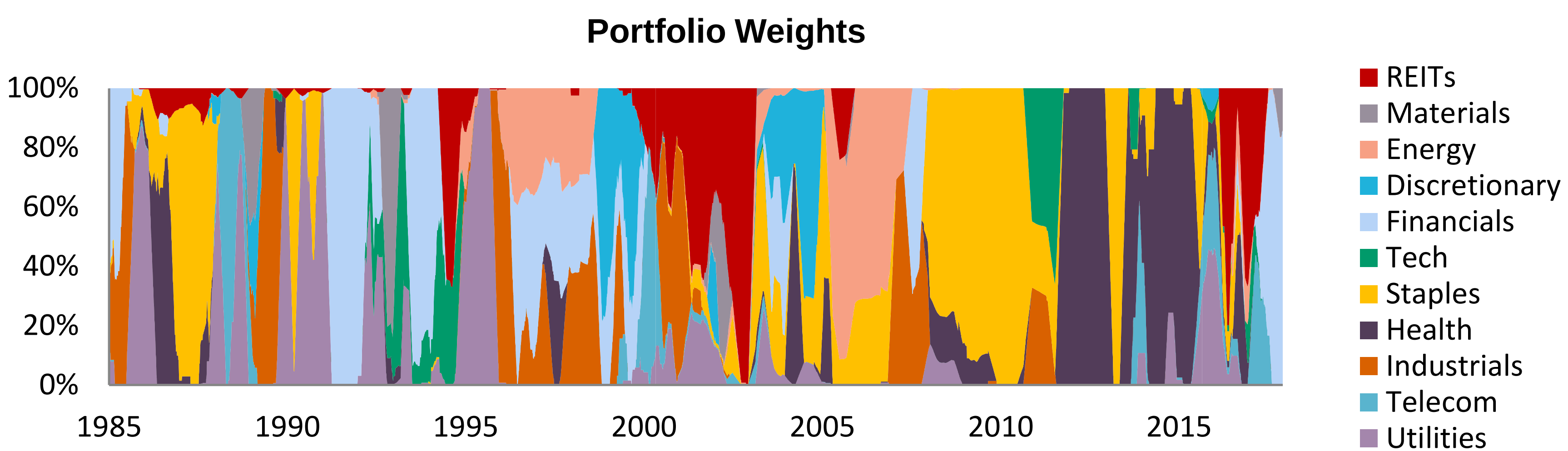
Annualized Performance

	Market	Sector Rotation	Sector Rotation Relative Performance
Return	11.3%	15.5%	4.2%
Risk	17.3%	15.6%	8.5%
Ratio	0.66	1.00	0.49

See “Sector Rotation Backtest” slide for details. Results span 1985 to 2017. Source: DataStream, State Street Global Exchange.

Sector Rotation Backtest





See "Sector Rotation Backtest" slide for details. Results span 1985 to 2017. Average portfolio turnover is 1.7x per year.
Source: DataStream, State Street Global Exchange.

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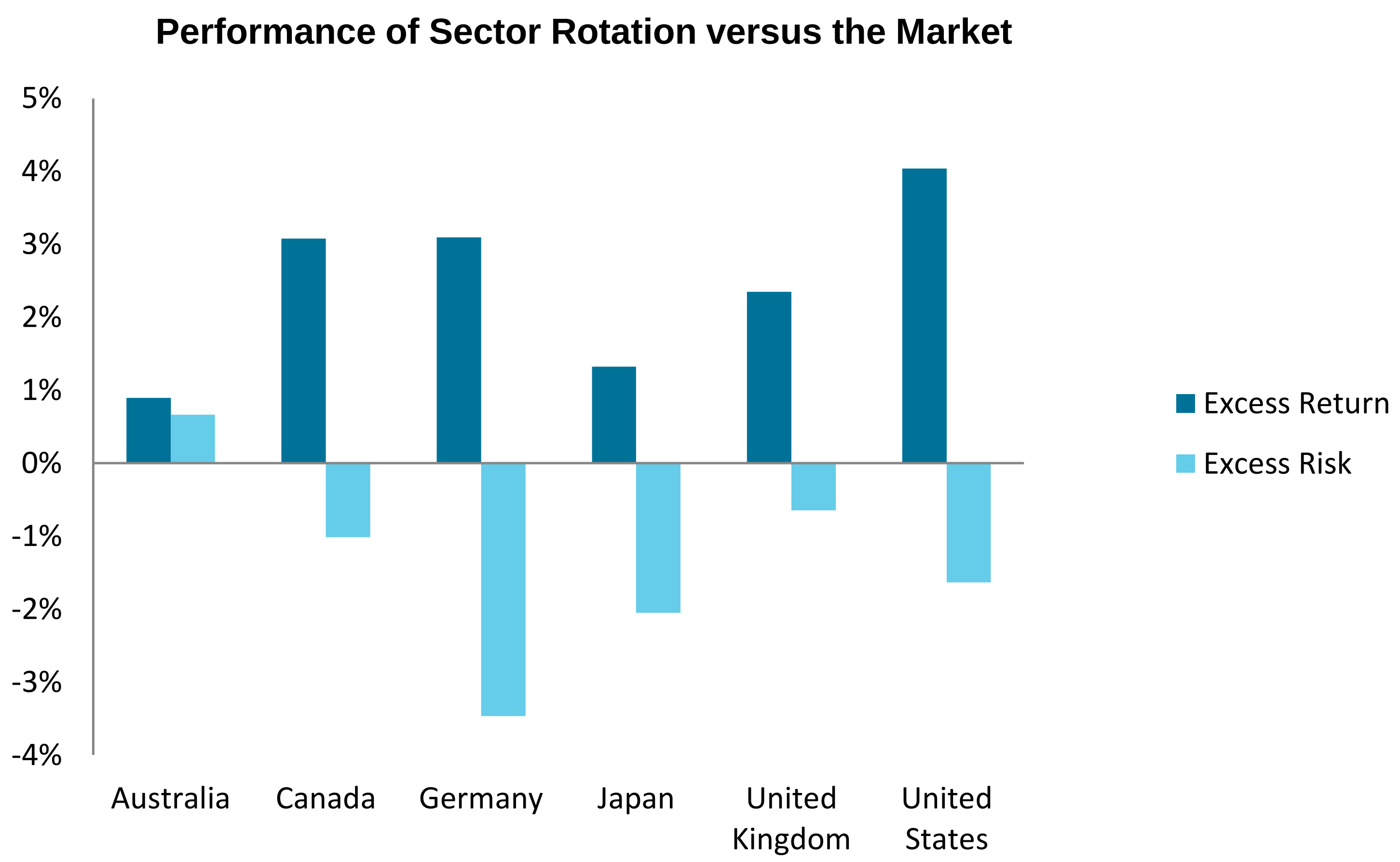
International Evidence



See "Sector Rotation Backtest" slide for details. Results span 1985 to 2017. Source: DataStream, State Street Global Exchange.

Conditional Factor Performance

- We analyze four factors that are prevalent in the literature: size, value, quality and low volatility.

- We do not analyze momentum because the constituents in a momentum portfolio change very frequently, which erodes the connection between crowding and security prices, and because momentum may be a consequence of crowding in other factors.

- We calculate centrality and relative value for each factor independently because, unlike sectors, multiple factors may contain the same stocks.

- We do not weight the factor decile returns by market capitalization because we do not expect size to relate to factor relevance in the way it does for sectors.

Conditional Factor Performance

Factor Definitions:

1. Annually rank stocks within the S&P 500 by one of four attributes:
   - Market capitalization (small size)
   - Price to book value ratio (low valuation)
   - Return on equity (high quality)
   - Prior two-year daily return volatility (low volatility)

2. Construct market capitalization weighted portfolios for each of 10 deciles, with an equal number of securities in each portfolio.

3. Define a factor portfolio for a given attribute as the capitalization-weighted average of the top two deciles.

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Conditional Factor Performance Relative to S&P 500

	Not Crowded	Crowded
Not Overvalued	No Bubble -2.4% *-0.32*	Bubble Run Up* **11.4%** ***1.22***
Overvalued	No Bubble 0.1% *0.02*	Bubble Sell Off **2.4%** ***0.34***

* Filtered for factors that have experienced positive returns over the prior year.

Numbers in italics are risk-adjusted returns. See preceding methodology slide for details. Results span 1995 to 2017. Source: DataStream, State Street Global Exchange.

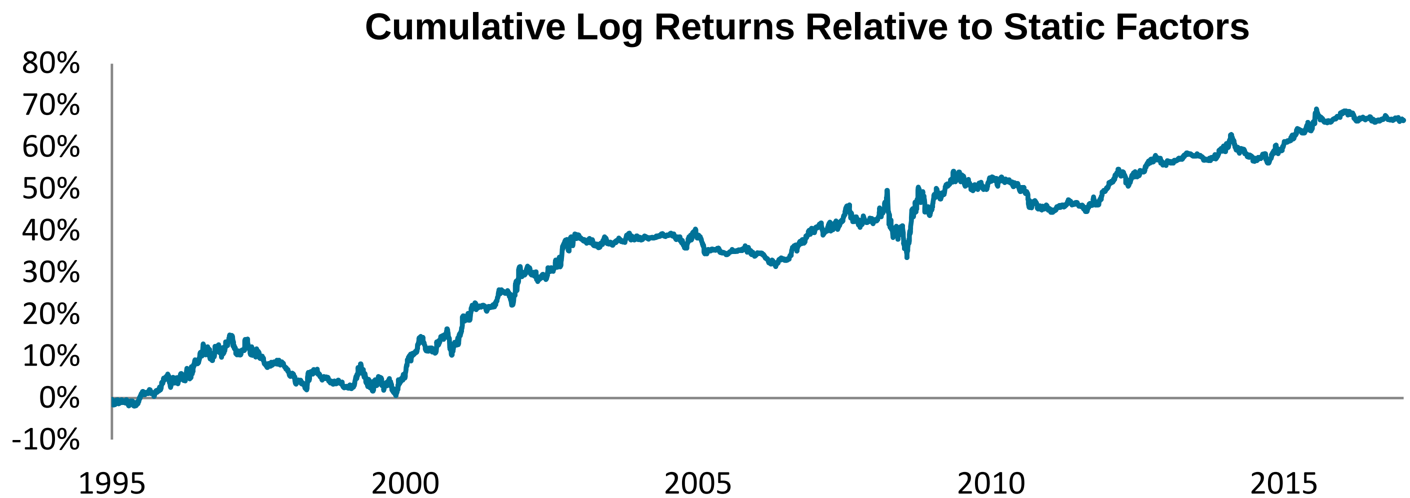
Factor Timing Backtest

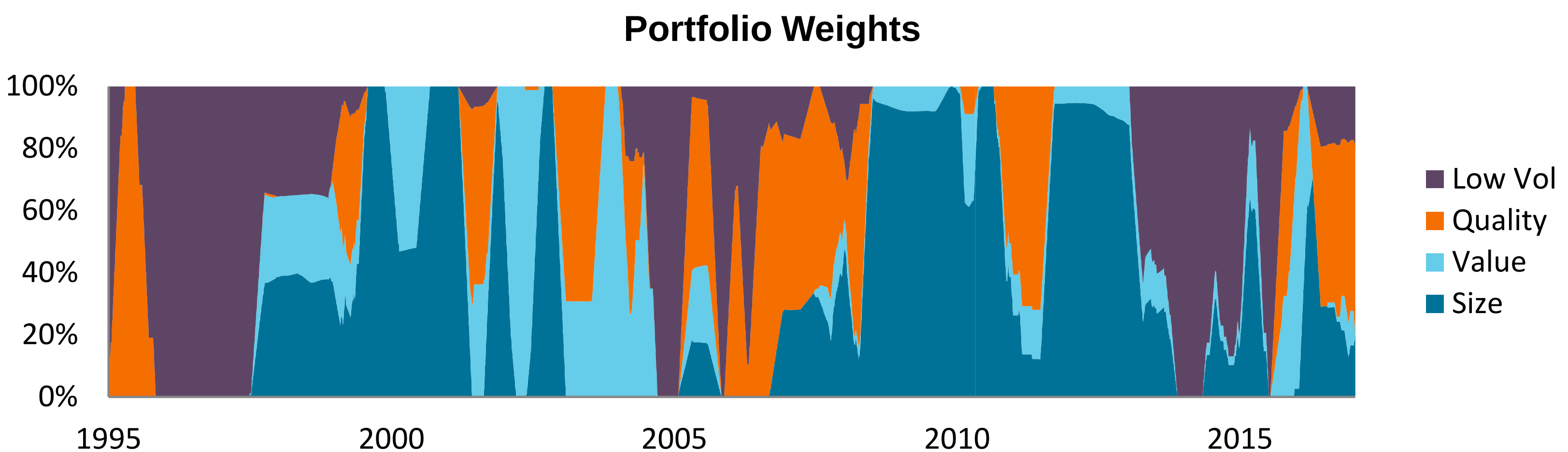
Annualized Performance

	S&P 500	Static Factors	Factor Timing	Static Factors Relative Performance	Factor Timing Relative Performance
Return	8.6%	11.6%	14.9%	3.0%	6.3%
Risk	18.6%	20.5%	20.8%	3.7%	5.7%
Ratio	0.46	0.56	0.71	0.82	1.10

Results span 1995 to 2017. Source: DataStream, State Street Global Exchange.

Factor Timing Backtest





Results span 1995 to 2017. Average portfolio turnover is 1.3x per year. Source: DataStream, State Street Global Exchange.

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Summary

- Centrality is very effective at locating crowded trading that often leads to the formation of bubbles.
- But centrality by itself cannot distinguish a bubble's run-up from its sell-off.
- Relative value is very effective at distinguishing a bubble's run-up from its sell-off.
- But relative value by itself cannot distinguish price activity that is driven by fundamentals from price activity that is driven by investor psychology.
- We, therefore, combine centrality with relative value to locate bubbles and to manage exposure to them.
- We present evidence suggesting that these two measures used together can help investors manage exposure to both sectors and factors for the purpose of generating significant excess returns.

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