CROWDED TRADES:
IMPLICATIONS FOR SECTOR ROTATION AND
FACTOR TIMING

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AGENDA

- Asset Centrality
- Relative Value
- Asset Centrality and Relative Value during Well-Known Bubbles
- Conditional Sector Performance
- Conditional Factor Performance
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

Centrality measures the extent to which a particular group of assets, such as a sector, drives the variability of returns:

Centrality is higher to the extent:

- The sector is relatively more volatile.
- The sector is connected to other assets.

\[
C_i = \frac{\sum_{j=1}^{n} (AR^j \cdot |w_i^j|)}{\sum_{j=1}^{n} AR^j}
\]

- \(C_i\) = 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

Why is centrality indicative of crowded trading?

- Centrality is characterized by high volatility and greater connectivity.
- Crowded trading leads to large order imbalances and therefore large price adjustments, which increases volatility.
- Crowding into a sector raises the correlation among the companies within the sector, which raises the sector’s volatility.
- Investors crowd toward sectors that are bellwethers, which tend to drive the behavior of other sectors, thus raising the connectivity of the bellwether sector.
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. Source: State Street Global Exchange.
To determine the relative value of a sector, we first compute its price-to-book value ratio.

We then normalize this valuation measure by dividing it by its long-term average, because some sectors have consistently higher price-to-book value ratios than others.

We then divide each sector’s normalized price-to-book value ratio by the average of the normalized price-to-book value ratios of all the other sectors to arrive at a cross-sectional measure of relative value.
The Power of Centrality and Relative Value Together

- Centrality is indicative of crowded trading.

- Crowded trading helps to locate bubbles by distinguishing price behavior that is induced by investor psychology from price behavior that is induced by shifting fundamentals.

- However, crowded trading occurs throughout the entire cycle of a bubble.

- Relative value is critical because it separates crowded trading that occurs during the run-up of a bubble from crowded trading that occurs during a bubble’s sell off.

Price

Centrality

Relative Value

Centrality for the U.S. Technology sector is computed across a universe of 11 U.S. sector indices from DataStream. Centrality and relative value are calculated using the methodology described on the "Asset Centrality and Relative Value" slide. Source: DataStream, State Street Global Exchange.

Price

Centrality

Relative Value

Centrality for the U.S. REITs sector is computed across a universe of 11 U.S. sector indices from DataStream. Centrality and relative value are calculated using the methodology described on the “Asset Centrality and Relative Value” slide. Source: DataStream, State Street Global Exchange.
STYLIZED BUBBLE

Run-up  Transition  Sell-off

Price

Time

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STYLIZED BUBBLE

Price

Time

Run-up
Transition
Sell-off

Overweight
Underweight

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Proof of Concept:

1. Rank all sectors by their centrality and relative value scores, as defined previously.

2. Identify the sectors that rank in the top three by both measures.

3. Form portfolios for four combinations of crowding and relative value:
   - not top three overvalued, not top three crowded (no bubble)
   - not top three overvalued, top three crowded, increase in price over the prior year (bubble run up)
   - top three overvalued, not top three crowded (no bubble)
   - top three overvalued, top three crowded (bubble sell off)

4. Record the performance of each portfolio.

5. Move to the next day and repeat.
When there is no crowding, we should not expect much separation between sectors that are not overvalued and those that are. However, when there is crowding, we should expect sectors that are not overvalued to outperform sectors that are overvalued.

*Filtered for sectors that have experienced an increase in price over the prior year.
## Conditional Sector Performance Relative to S&P 500

*Filtered for sectors that have experienced an increase in relative value during the previous three months.

<table>
<thead>
<tr>
<th></th>
<th>Not Crowded</th>
<th>Crowded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not Overvalued</td>
<td>No Bubble</td>
<td>Bubble Run Up*</td>
</tr>
<tr>
<td></td>
<td>0.5%</td>
<td>7.4%</td>
</tr>
<tr>
<td>Overvalued</td>
<td>No Bubble</td>
<td>Bubble Sell Off</td>
</tr>
<tr>
<td></td>
<td>1.4%</td>
<td>-6.5%</td>
</tr>
</tbody>
</table>

*Filtered for sectors that have experienced an increase in relative value during the previous three months.*
INTERNATIONAL EVIDENCE

Sectors Experiencing a Run Up

Sectors Experiencing a Sell Off

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## International Evidence

<table>
<thead>
<tr>
<th></th>
<th>Bubble Run Up</th>
<th>Bubble Sell Off</th>
<th>Spread</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>3.8%</td>
<td>3.5%</td>
<td>0.3%</td>
</tr>
<tr>
<td>Canada</td>
<td>5.7%</td>
<td>-4.6%</td>
<td>10.3%</td>
</tr>
<tr>
<td>Germany</td>
<td>4.3%</td>
<td>0.8%</td>
<td>3.5%</td>
</tr>
<tr>
<td>Japan</td>
<td>2.1%</td>
<td>-2.7%</td>
<td>4.8%</td>
</tr>
<tr>
<td>UK</td>
<td>5.1%</td>
<td>0.7%</td>
<td>4.4%</td>
</tr>
<tr>
<td>US</td>
<td>7.4%</td>
<td>-6.5%</td>
<td>13.9%</td>
</tr>
</tbody>
</table>
Does it work with factors?
CONDITIONAL FACTOR PERFORMANCE

Computing Factor Portfolios:

1. Annually rank stocks by one of four attributes (size, value, quality, and low volatility) and allocate an equal number of stocks into each of 10 deciles.

2. Form a capitalization-weighted portfolio from the stocks in each decile.

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

1. Obtain daily total returns for the factor portfolio for the previous two years.

2. Compute a covariance matrix using exponential decay weights with a half-life of one year.

3. Estimate centrality for each decile portfolio using the top two principal components.

4. Sum the centralities for the top two deciles that comprise the factor.

5. Compute a standardized shift of the factor’s centrality based on the previous three years.
Computing Factor Relative Value:

1. Obtain daily price-to-book value ratios for each decile portfolio.

2. Compute capitalization-weighted averages for the top two deciles that define the factor.

3. Divide the current ratio by the average ratio over the previous 10 years to normalize it. (We initially use five years and grow the window to extend back the sample period.)

4. Divide the normalized ratio by the normalized ratio associated with the other eight decile portfolios.
### Conditional Factor Performance

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

<table>
<thead>
<tr>
<th></th>
<th>Not Crowded</th>
<th>Crowded</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Not Overvalued</strong></td>
<td>No Bubble: -2.4%</td>
<td>Bubble Run Up*: 9.7%</td>
</tr>
<tr>
<td><strong>Overvalued</strong></td>
<td>No Bubble: -0.2%</td>
<td>Bubble Sell Off: 3.8%</td>
</tr>
</tbody>
</table>

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Back Test of Factor Timing Strategy:

1. Construct a baseline strategy consisting of equal allocations across the four factors (size, value, quality, and low volatility).
2. Assign ranks to each factor according to its centrality and relative value.
3. Flag factors that are among the top two most crowded factors but not among the top two most highly valued factors, and whose return relative to the market has been positive over the previous year. (Run-up phase of a bubble)
4. Flag factors that are among the top two most crowded factors and among the top two most highly valued. (Sell-off phase of a bubble)
5. Form equally weighted portfolios of whichever factors (if any) meet the conditions for inflating bubbles.
6. If no factors meet this condition, invest the portfolio in the market benchmark.
7. Do the same for factors that are in the sell-off phase of a bubble.
8. Possible weights:
   - 100% market portfolio
   - 100% in a factor
   - 50% in each of two factors
Performance in Excess of Market Return

Return = 5.5%
Return/Risk = 0.79

Return = 2.8%
Return/Risk = 0.42

Return = 2.7%
Return/Risk = 0.61
Summary

- Centrality, which measures crowded trading, is effective at locating bubbles.

- But centrality by itself cannot distinguish the run-up phase of a bubble from the sell-off phase of a bubble.

- Relative value by itself cannot distinguish run-ups that are justified by fundamentals from run-ups that are driven by investor psychology.

- Centrality, combined with relative value, locates bubbles and separates the run-up from the sell-off phase.

- Evidence suggests 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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