Portfolio Allocation with Cluster Risk Parity

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Outline

- Cluster Risk Parity Algorithm
- Step by Step
- Portfolio Weights
- Clustering methods
- Back tests
- Advantages
Cluster Risk Parity (CRP)

- Heuristic portfolio allocation method that uses
  - Dynamic Clustering to discover market macro-structure
  - Risk Parity to normalize risk within and across clusters
- Adaptive
- Maximize Portfolio Diversification
Steps to construct CRP portfolio

1. Create groups (clusters) of assets
2. Create risk parity portfolios within each group
3. Distribute weights across clusters using risk parity
Weights

ERC Weights

Cluster ERC Weights

- US Dollar UUP: 43%
- Treasuries TLT: 17%
- Gold GLD: 13%
- EmergingM EEM: 15%
- InternationalM EFA: 13%
- Nasdaq QQQ: 15%
- Oil USO: 24%
- Real Estate IYR: 15%
- S&P500 SPY: 32%
- Small Cap IWM: 17%
Clustering

- **Method:**
  - Hierarchical
  - K-Means

- **Optimal Number of clusters:**
  - Percentage of Variance explained
  - Elbow point

- Look back window to construct clusters
Historical Evolution of Clusters

DOW 30

S&P 500
## CRP Back-test Performance

### 10 Major Asset Classes

<table>
<thead>
<tr>
<th>Asset Class</th>
<th>Return</th>
<th>Sharpe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equal Weight</td>
<td>7.70</td>
<td>0.52</td>
</tr>
<tr>
<td>Risk Parity</td>
<td>7.20</td>
<td>0.68</td>
</tr>
<tr>
<td>Risk Parity - ERC</td>
<td>7.75</td>
<td>0.98</td>
</tr>
<tr>
<td>Dynamic Clustering with Equal Weight</td>
<td>9.15</td>
<td>0.80</td>
</tr>
<tr>
<td>Dynamic Clustering with Risk Parity</td>
<td>8.39</td>
<td>1.03</td>
</tr>
<tr>
<td>Dynamic Clustering with Risk Parity - ERC</td>
<td>8.18</td>
<td>1.08</td>
</tr>
<tr>
<td><strong>Average Risk Parity Variants</strong></td>
<td>7.48</td>
<td>0.83</td>
</tr>
<tr>
<td><strong>Average Dynamic Clustering Variants</strong></td>
<td>8.29</td>
<td>1.06</td>
</tr>
</tbody>
</table>

### DOW 30 Stocks

<table>
<thead>
<tr>
<th>Asset Class</th>
<th>Return</th>
<th>Sharpe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equal Weight</td>
<td>12.67</td>
<td>0.69</td>
</tr>
<tr>
<td>Risk Parity</td>
<td>12.46</td>
<td>0.71</td>
</tr>
<tr>
<td>Risk Parity - ERC</td>
<td>12.25</td>
<td>0.71</td>
</tr>
<tr>
<td>Static Clustering with Equal Weight</td>
<td>12.41</td>
<td>0.68</td>
</tr>
<tr>
<td>Static Clustering with Risk Parity</td>
<td>12.27</td>
<td>0.71</td>
</tr>
<tr>
<td>Static Clustering with Risk Parity - ERC</td>
<td>12.12</td>
<td>0.71</td>
</tr>
<tr>
<td>Dynamic Clustering with Equal Weight</td>
<td>13.52</td>
<td>0.72</td>
</tr>
<tr>
<td>Dynamic Clustering with Risk Parity</td>
<td>12.90</td>
<td>0.74</td>
</tr>
<tr>
<td>Dynamic Clustering with Risk Parity - ERC</td>
<td>12.92</td>
<td>0.75</td>
</tr>
<tr>
<td><strong>Average Risk Parity Variants</strong></td>
<td>12.36</td>
<td>0.71</td>
</tr>
<tr>
<td><strong>Average Static Clustering Variants</strong></td>
<td>12.20</td>
<td>0.71</td>
</tr>
<tr>
<td><strong>Average Dynamic Clustering Variants</strong></td>
<td>12.91</td>
<td>0.75</td>
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</tbody>
</table>
Cluster Risk Parity

- Heuristic
- Adaptive
- Maximize Portfolio Diversification
The End

Please visit my blog at www.systematicinvestor.wordpress.com for more examples and ideas.
References

Download R Code at www.systematicportfolio/RFinance2013

Systematic Investor blog

- Clustering with selected Principal Components
- Examples of Current Major Market Clusters
- Optimal number of clusters
- Tracking Number of Historical Clusters
- Tracking Number of Historical Clusters in DOW 30 and S&P 500
- Cluster Portfolio Allocation
- Cluster Risk Parity back-test

CSS Analytics blog

- Cluster Risk Parity
- Cluster Risk Parity – A Visual Representation
- Cluster Risk Parity (CRP) versus Risk Parity (RP) and Equal Risk Contribution (ERC)
- A Visual of Current Major Market Clusters
- A Backtest Using Dynamic Clustering versus Conventional Risk Parity Methods
- Dynamic versus Static Clustering: Dow 30 Stocks 1995-Present
- Static versus Dynamic Clustering on Multiple Asset Classes