

# Mapping Heat in the U.S. Financial System

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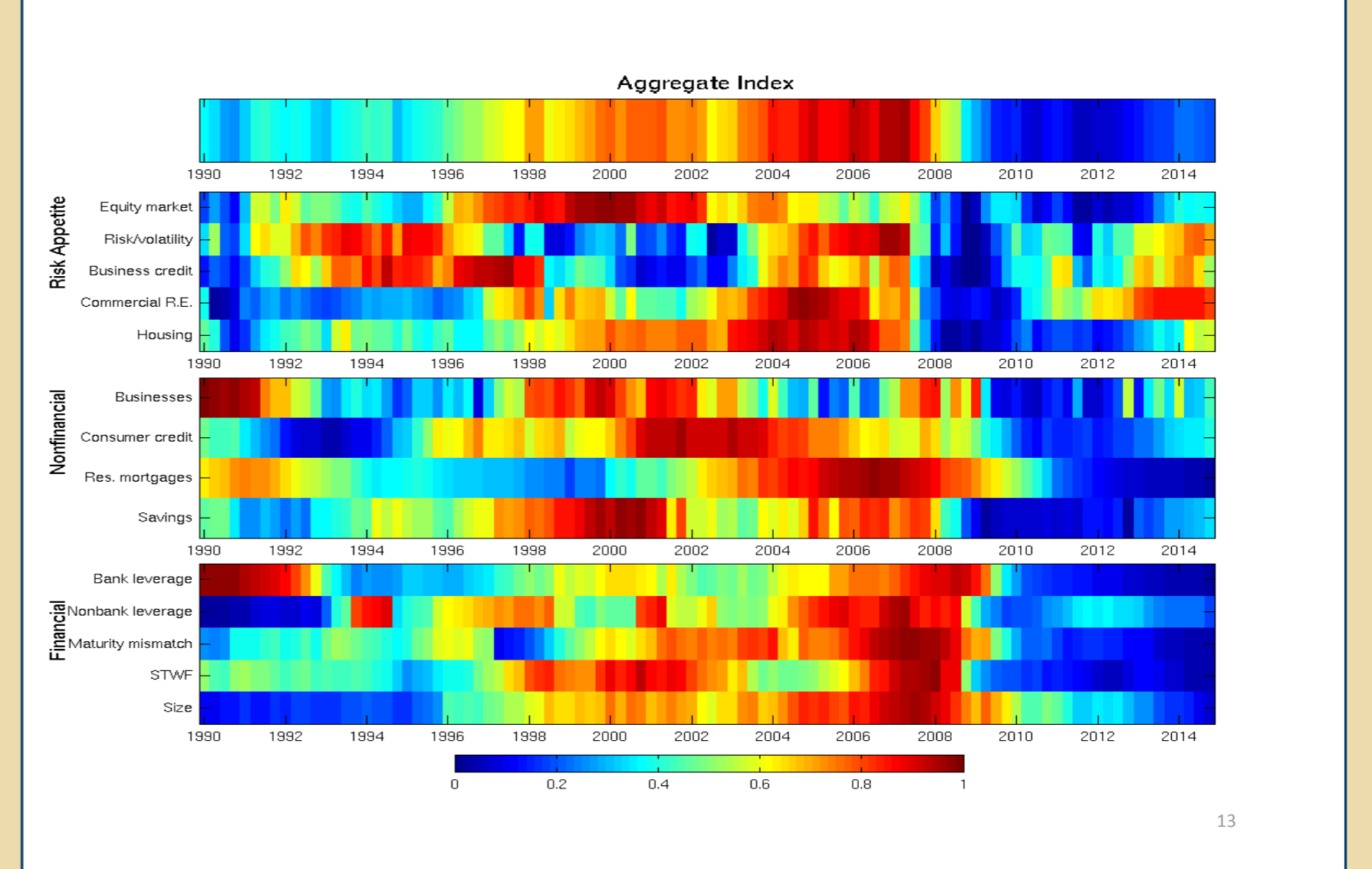
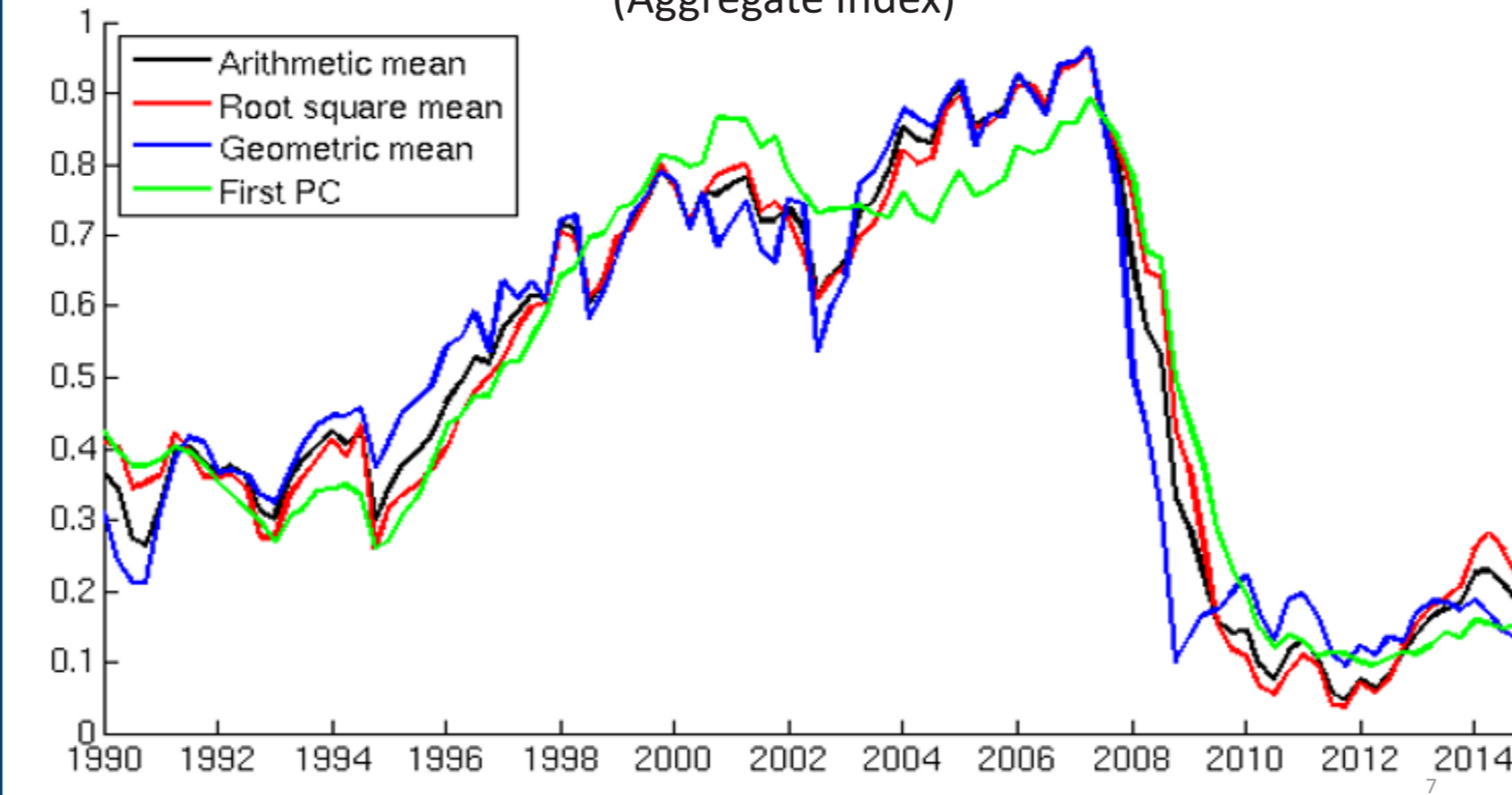
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## Policy background and motivation

- Holistic efforts to monitor vulnerabilities in the financial system are crucial to mitigating threats to financial stability through macroprudential tools or other policy actions
- Other official sector institutions have come up with frameworks to monitor financial fragility and risks in the financial system
- At the Fed, the Quantitative Surveillance (QS) process uses expert judgment to identify and quantify the build-up of U.S. financial system vulnerabilities that can contribute to the amplification of economic and financial shocks

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## Impact of alternative weighting approaches (Aggregate Index)



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## Literature on indicators of financial vulnerabilities

- Early warning indicators for banking and currency crises**
  - Surveyed in Kaminsky, Lizondo, and Reinhart (1998)
- Credit booms**
  - Minsky (1972), Borio and Lowe (2002, 2004), Reinhart and Rogoff (2010), Drehmann, Borio, and Tsatsaronis (2012), Shularick and Taylor (2012)
- Funding of credit booms**
  - Diamond and Rajan (2001), Adrian and Shin (2010), Kirshnamurthy and Vissing-Jorgensen (2013), Brunnermeier and Oehmke (2013)
- Inflated asset prices**
  - Cecchetti (2008), Stein (2013), Brunnermeier and Sannikov (2014), Adrian and Brunnermeier (2014)
- Concentration**
  - Duarte and Eisenbach (2013)
- Variety of potential vulnerabilities**
  - Eichner, Kohn, and Palumbo (2010), Adrian, Covitz, and Liang (2013)

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## Data visualization

- Radar charts – good for simultaneously plotting readings on all 14 component measures at particular points in time
- Coxcomb charts – invariant to ordering of components and can make area proportional to the index of each component
- Heat maps – good for placing the 14 components in a longer historical context and identifying correlations and lead-lag relationships

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## Comparison with the U.S. credit-to-GDP gap

- Credit-to-GDP gap (CGG) is popular
  - Used widely in the academic/policy financial cycle literature as a financial stability monitoring tool and is considered a good Early Warning Indicator (EWI) of systemic banking crises, especially for advanced economies
  - Proposed as a guide for setting the countercyclical capital buffer (CCyB) by the Basel Committee on Banking Supervision (2010)
- But it has some drawbacks
  - Difficulty in estimating and interpreting the trend of the credit-to-GDP ratio
  - More recent literature shows that vulnerabilities may also depend on the different types of funding of credit booms, so need a holistic approach that may detect financial vulnerabilities earlier
  - Both credit and GDP can contribute to elevated CGGs even after financial crises

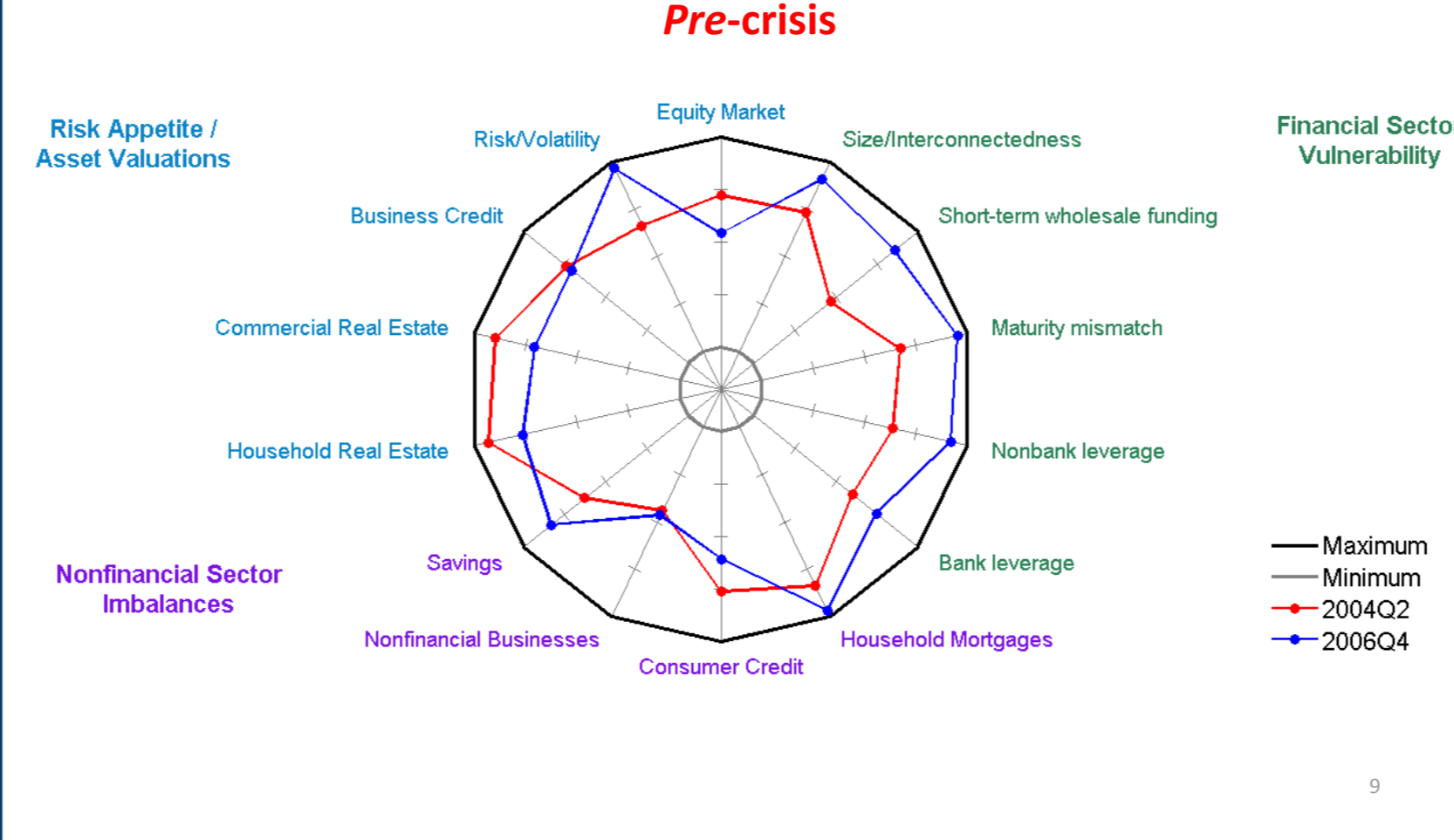
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## Goal and challenges

- Our goal is to construct quantitative measures of vulnerabilities to provide an 'algorithmic' and transparent complement to judgmental assessments of financial vulnerabilities for the U.S. financial system which can discipline judgment and potentially help with macroprudential policy such as the countercyclical capital buffer
- Challenges due to large amounts of data
  - Data categorization
  - Data processing and aggregation
  - Data visualization

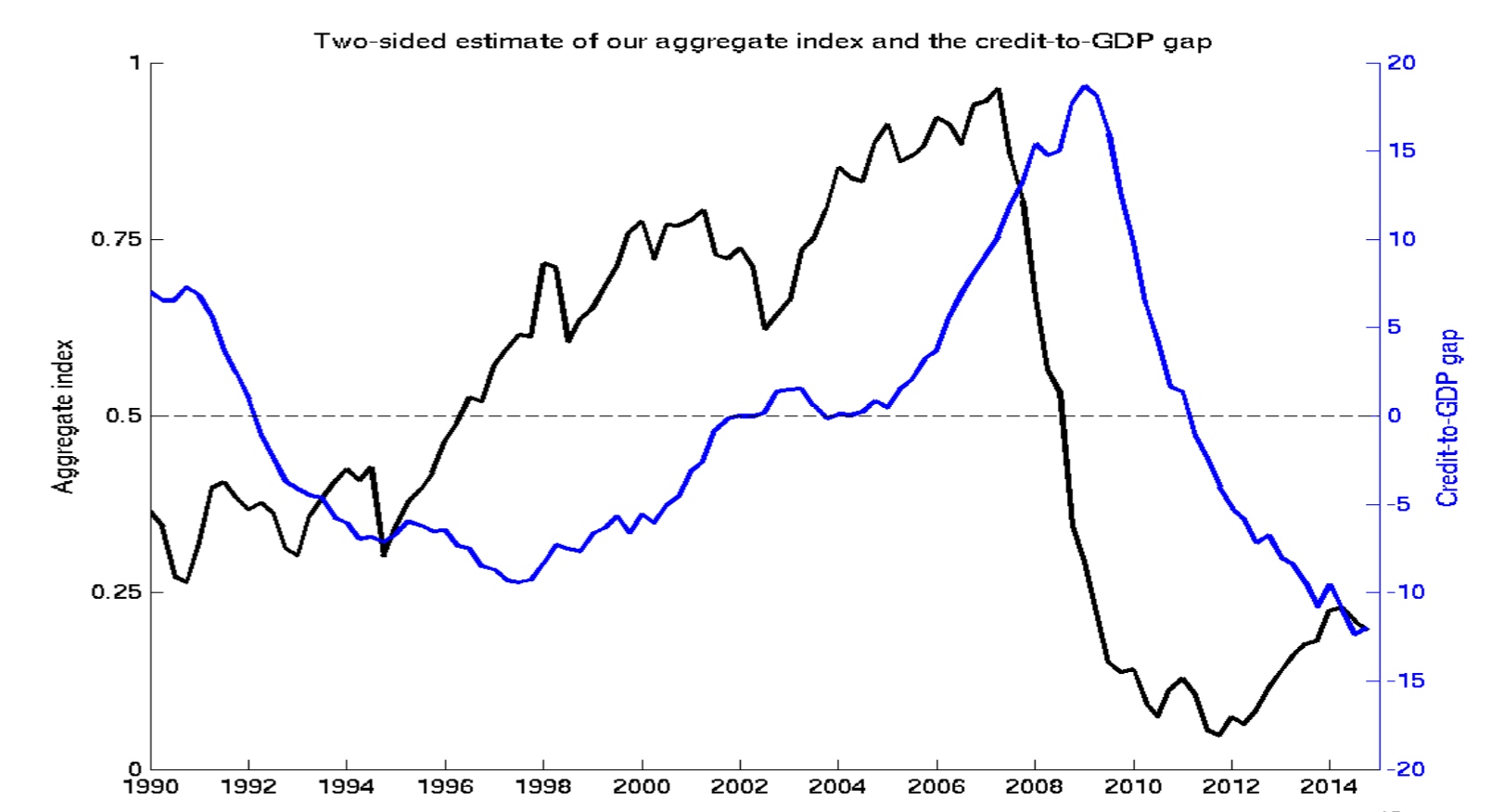
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## Radar charts of financial system vulnerabilities



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## Aggregate index and the U.S. credit-to-GDP gap



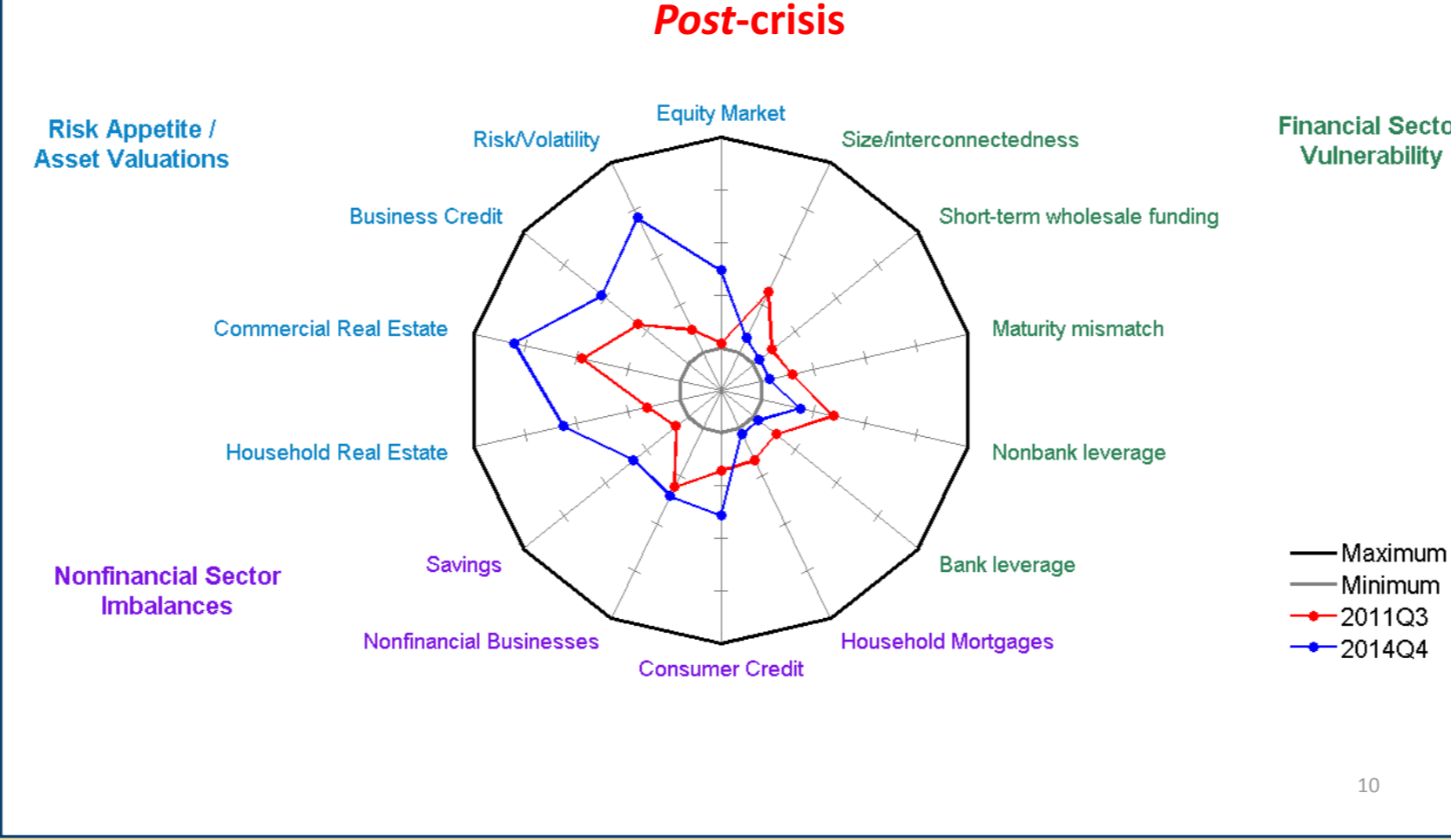
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## Data categorization

- Focus is on aggregating information from a wide span of indicators, covering risk appetite, nonfinancial sector imbalances and financial sector vulnerability in an intuitive way
- Gather 44 indicators that are mainly based on variables or vulnerabilities emphasized in the literature – group into 14 'core components'
  - Risk Appetite – Housing, Commercial Real Estate, Business Debt and Loans, Equity Markets, Price Volatility
  - Nonfinancial – Nonfinancial Business, Consumer Credit, Home Mortgages, Net Saving
  - Financial – Bank Leverage, Nonbank Leverage, Maturity Transformation, Short-Term Funding, Size/Concentration
- We take as given that a variety of factors have been shown to have predictive power over the build-up of financial system vulnerabilities

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## Radar charts of financial system vulnerabilities



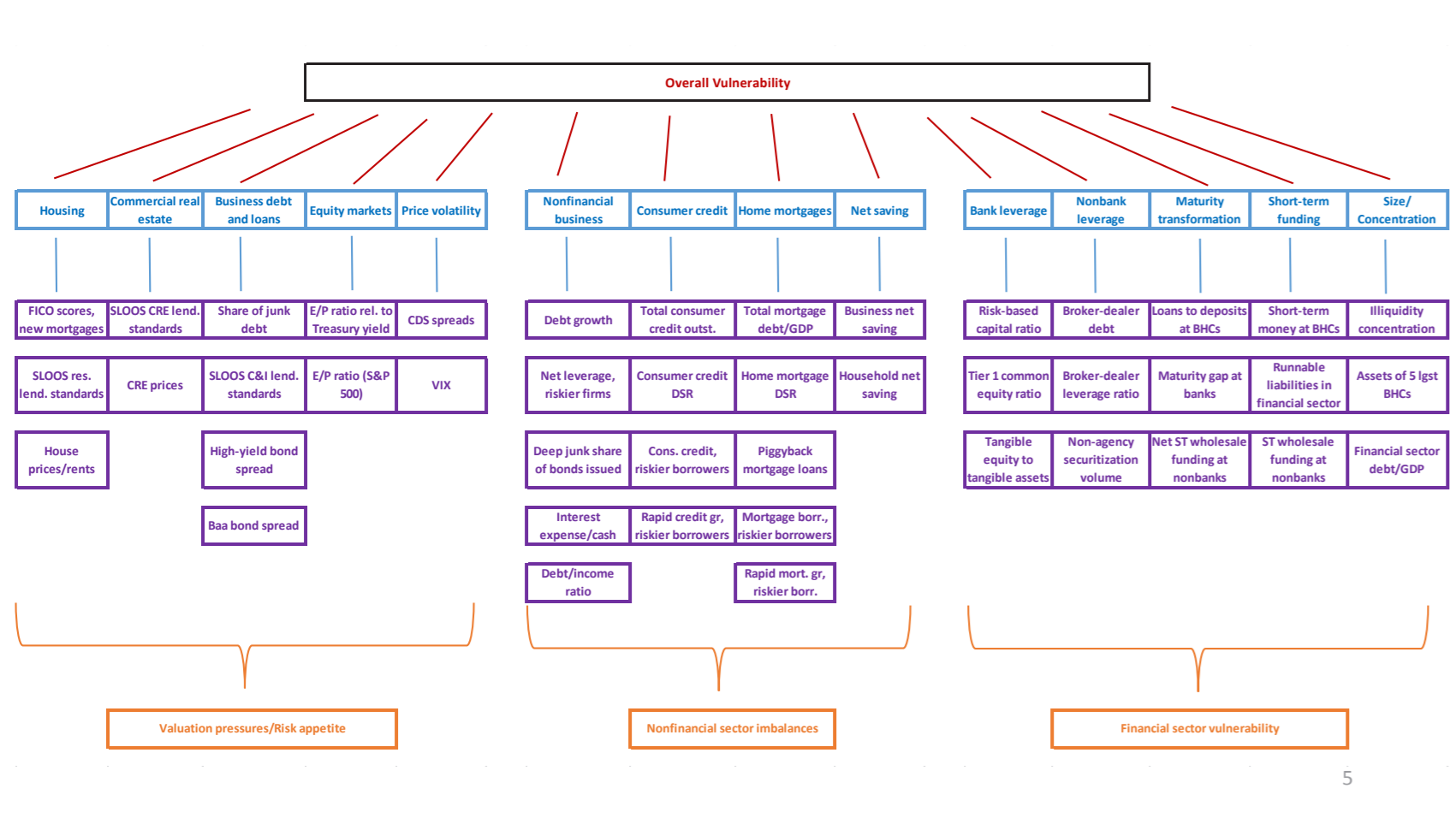
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## Application to countercyclical capital buffer

- Aggregate index Granger-causes CGG (about two years)
  - Can test a variety of lead-lag relationships in cross-correlation functions and in a VAR framework
  - May be useful for determining macroprudential policies
- Example: Countercyclical capital buffers (CCyBs) at banks
  - Early detection of increased vulnerabilities is useful because activation of buffer may potentially require significant lags
  - Early signal of financial disintermediation (in a crisis) is useful because may not need to depend on yet another index/variable for release of the buffer
  - Some quantitative examples (but have to remember the Lucas critique)

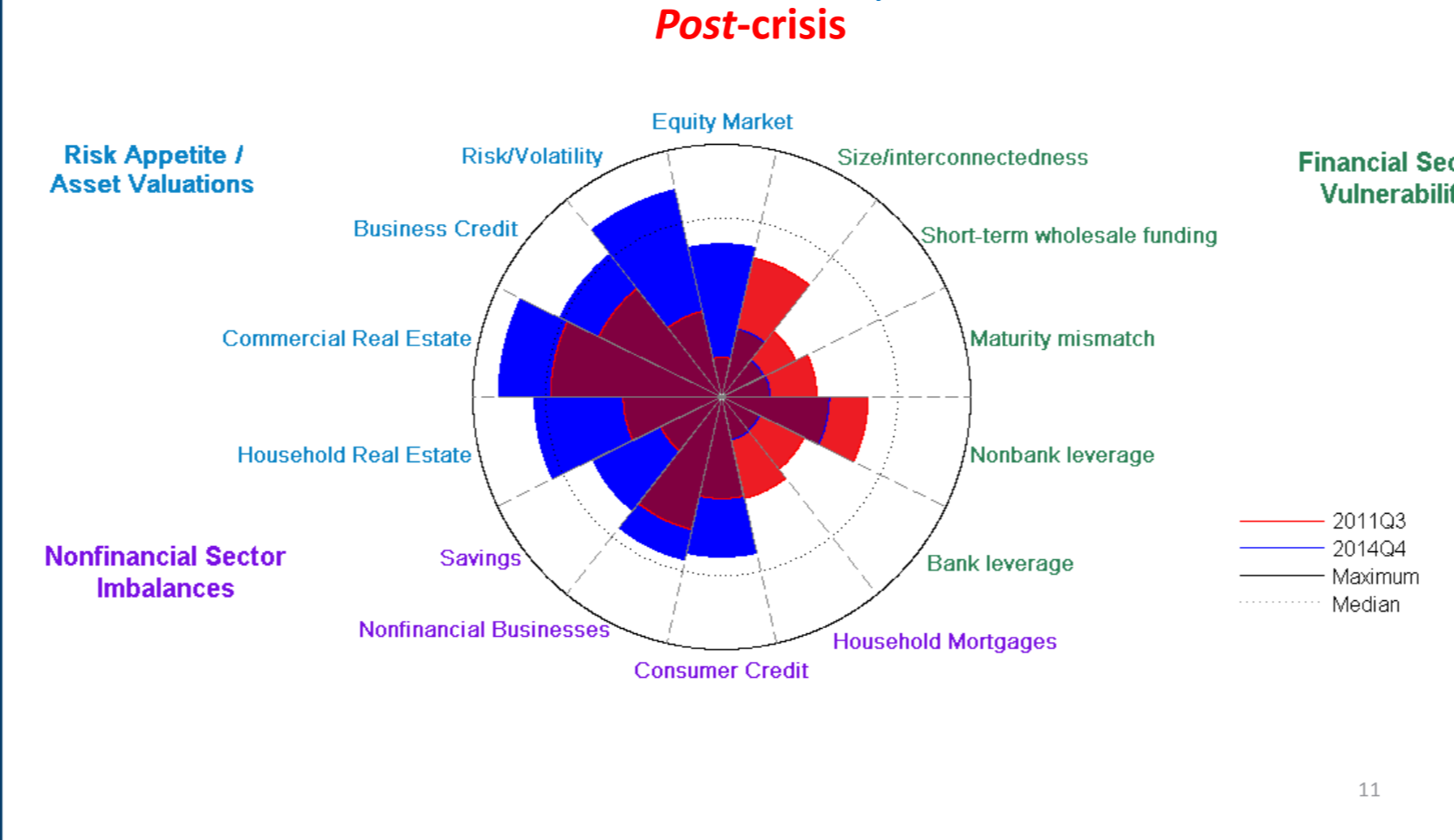
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## Categorizing our indicators



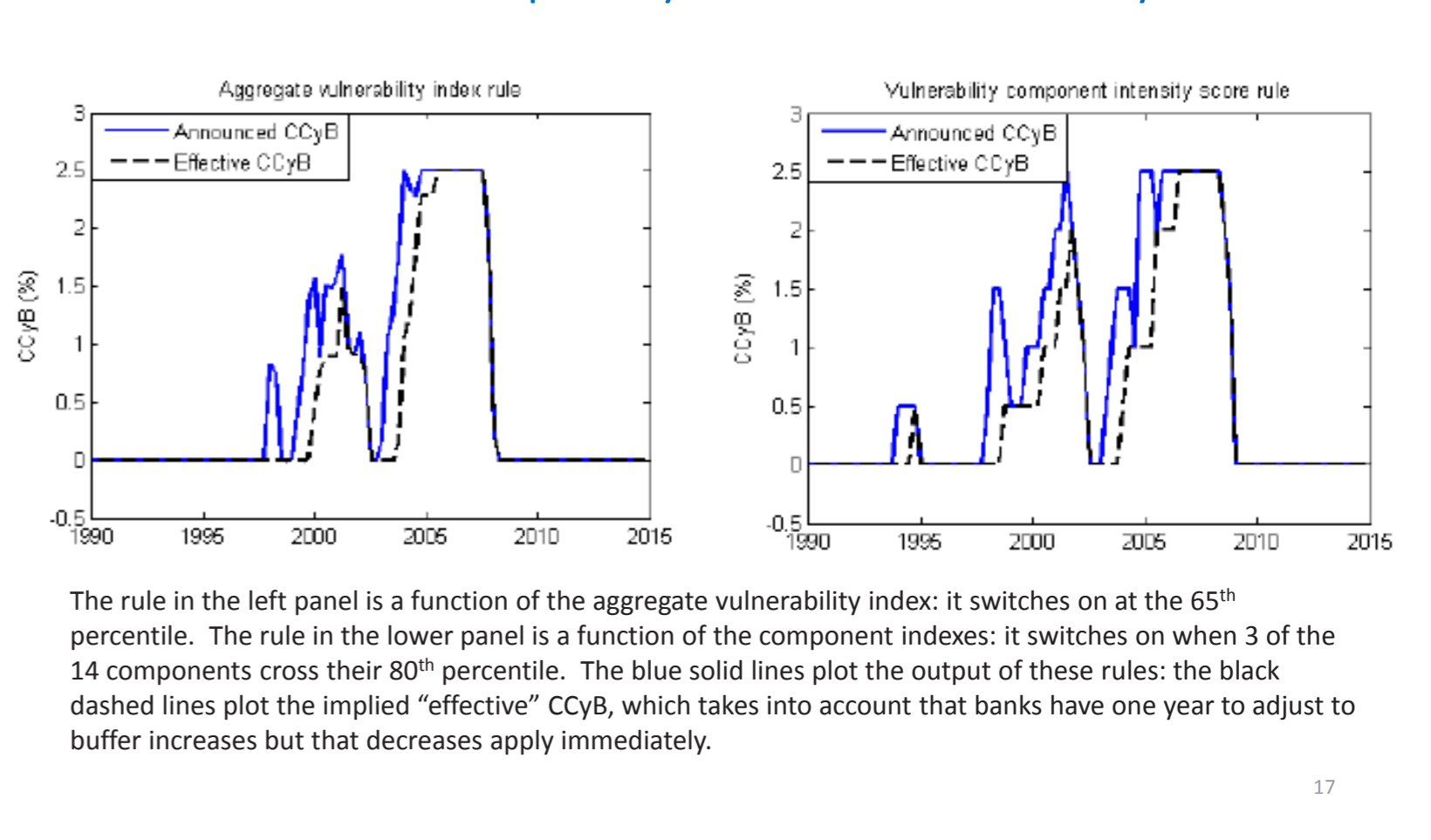
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## Coxcomb charts of financial system vulnerabilities



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## Illustrative policy rules for the CCyB



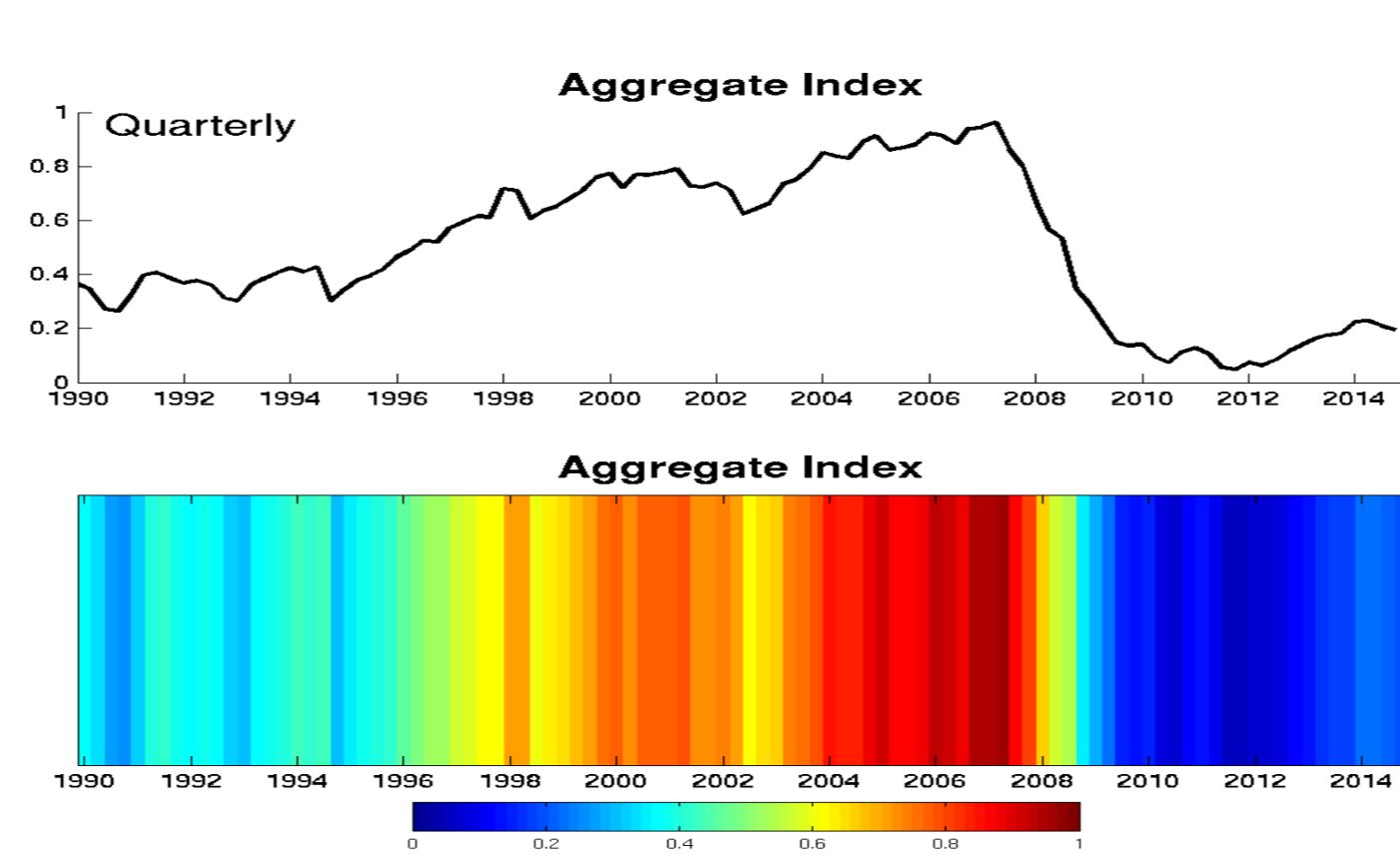
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## Data processing and aggregation

- Step 1: Standardize** each of the 44 indicators to place them on an 'equal footing'
  - De-trend if necessary
  - Subtract sample average values (at most 25 years worth ending in 2014:Q4), then divide by sample standard deviations
  - Add indicators when data become available
- Step 2: Group** standardized indicators into 14 'component' sources of vulnerability covering risk appetite, nonfinancial imbalances and financial sector vulnerability
  - Component index is un-weighted average of standardized indicators
  - Rescale using kernel density estimates to place on [0, 1], so 0.5 is approximately the median
- Step 3: Aggregate** component indexes into overall index
  - Average across 14 components (equally weighted)
  - Rescale using kernel density estimates to place on [0, 1]

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## Aggregate 'heat' map of vulnerabilities



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## Conclusion

- Main results**
  - Mechanical and transparent algorithm captures the last two decades
  - We provide visualization tools to track U.S. financial vulnerabilities
  - Our vulnerability measures lead the credit-to-GDP gap by two years
- Practical uses**
  - Complements input to staff's assessment of financial stability
  - Could be considered in countercyclical capital regulation
  - More generally, can be applied to different sectors and different countries
- Caveats**
  - Not well-suited for capturing ongoing structural vulnerabilities, vulnerabilities with no corresponding data (shadow banking), or new emerging risks
  - Results change depending on normalization and aggregation methods, and weighting scheme (but usually not by that much)

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