News and narratives in financial Systems
Exploiting big data for systemic risk assessment

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Agenda

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- Data
- Relative Sentiment Shifts
  - Methodology
  - Results
- Narrative Consensus
  - Methodology
  - Results
- Summary
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Background

• We recognise that narratives and emotions are key drivers behind economic and financial activity (e.g., Akerlof & Shiller, 2009; Tuckett, 2011)
  – Within the context of radical uncertainty, agents act by gaining conviction through the use of narratives
  – Such conviction narratives (Chong & Tuckett, 2014) must have emotional support to be acted upon – excitement about gain, suppressing doubt and anxiety about loss
  – Due to social interaction narratives may spread ‘systemically’
    • Shifts towards hot dotcoms, structured finance, tapering, cyber risk, etc.

• We recognise that financial markets can be homogenised because of a search for yield with top performers as the benchmark (Aikman et. al., 2011) - “keeping up with the Goldmans”
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Objectives

• With big text data and modern machine learning techniques, there are new possibilities to investigate the effect of narratives on the economy and financial markets

• This research attempts to address *two key questions*
  – Can we measure *shifts in relative sentiment*?
    • If so, how does the measure relate to economic confidence, financial exuberance and stability?
  – Can we measure structural shifts in the *distribution of narratives*?
    • In particular, can we measure ‘*narrative consensus*’ (homogenisation)

• We provide evidence of *increasing narrative consensus high in excitement and lacking anxiety*, leading up to the crisis, likely to be an important warning sign of impending distress
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## Data

<table>
<thead>
<tr>
<th>Data</th>
<th>Range</th>
<th>Description</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal Market Commentary</td>
<td>January 2000 through July 2010</td>
<td>Daily comments on market events</td>
<td>MCDAILY</td>
</tr>
<tr>
<td>Broker Circulars (Macro view)</td>
<td>January 2008 through June 2013</td>
<td>Low volume prior to June 2010. Primarily weekly economic research reports</td>
<td>BROKER</td>
</tr>
</tbody>
</table>
Relative Sentiment – Methodology

• Relative Sentiment Shifts
  – Theoretically motivated (and validated) word dictionaries are used
    • Excitement ~ 150 words, Anxiety ~ 150 words
  – Relative sentiment metric = ( |excitement| - |anxiety| ) / |characters|
    • Simplicity → more robust to data source, reduced complexity

• Excitement/Anxiety word samples
  – Amaze, amazed, amazes, amazing, attract, attracted, attraction, etc.
  – Anxiety, anxious, avoid, avoids, bother, bothers, bothered, etc.

• Bootstrap confidence intervals
  – Sample new weights for each word (weights sum to ~ 150)
  – Get a new sentiment point, repeat to get a distribution
  – Extract confidence intervals from the distribution
Internal Market Commentary (MC-DAILY) – relative sentiment shifts
Consistent with historically significant events
Biggest component of sentiment increase in mid-2000s is anxiety (red)
Series $x(t)$ smoothed using $y(t) = (1-a)y(t-1) + ax(t)$, with $a=0.3$
Largely correlated with **RTRS** (green) and **BROKER** (red)
Series $x(t)$ smoothed using $y(t) = (1-a)y(t-1) + ax(t)$, with $a=0.3$
Relative sentiment – How does this compare?

• To better understand what the relative sentiment of these data sources measure we do a few basic comparisons to some existing indicators
  – Simple pairwise correlations
• We look at a small set of ‘macro indicators’ and a small set of ‘market based indicators’
  – E.g., bank balance sheets, interest rates, credit to GDP gap
  – The choice of categories motivated by expectations from the data
  – ‘macro indicators’ include the Michigan Consumer Sentiment Index
  – ‘market based indicators’ include the VIX
• MCI and VIX comparisons stand out and illustrate what might be found from different data sources
MCDDAILY (black) and VIX (yellow)
Relative Sentiment – Detailed comparison

<table>
<thead>
<tr>
<th></th>
<th>MCDDAILY</th>
<th>RTRS</th>
<th>BROKER</th>
<th>VIX</th>
<th>MCI</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCDDAILY</td>
<td>1</td>
<td>0.56</td>
<td>0.29</td>
<td>-0.62(-0.66)</td>
<td>0.27</td>
</tr>
<tr>
<td>RTRS</td>
<td>-</td>
<td>1</td>
<td>0.73</td>
<td>-0.44</td>
<td>0.68</td>
</tr>
<tr>
<td>BROKER</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-0.36</td>
<td>0.58(0.87)</td>
</tr>
<tr>
<td>VIX</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-0.42</td>
</tr>
<tr>
<td>MCI</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
</tbody>
</table>

- MCI three weeks ahead (since June 2010 in brackets)
- VIX within month daily average (one month ahead in brackets)

Granger tests

<table>
<thead>
<tr>
<th></th>
<th>1 lag, p-value</th>
<th>2 lags, p-value</th>
<th>3 lags, p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCDDAILY -&gt; VIX</td>
<td>0.0009025 ***</td>
<td>0.003614 **</td>
<td>0.04153 *</td>
</tr>
<tr>
<td>VIX -&gt; MCDDAILY</td>
<td>0.09649</td>
<td>0.2874</td>
<td>0.289</td>
</tr>
</tbody>
</table>
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Consensus in Reuters News

• From a financial stability perspective it is of interest to analyse the content of *narratives*
  – To identify risk areas (e.g., housing)
  – To measure narrative *consensus* (as a risk to financial stability)
• We will attempt to quantify ‘consensus’ in Reuters, by measuring
  – The number of narratives at a given moment
  – The ‘size’ of each such narrative
• In particular, our measure should satisfy two properties
  – If the number of narratives drops – consensus should increase
  – If some narrative grows to dominate – consensus should increase
• A measure that would achieve these two criteria is the *entropy* of the distribution of topics
  – Entropy is essentially a measure of ‘dispersion’ of a distribution
Consensus – Methodology

• A machine learning approach to automatic topic detection
  – We cluster documents after mapping them to vectors

• Vectors created from word/document occurrence statistics
  – Create a word by document frequency matrix
  – Remove uninformative words - with extreme (low/high) frequency

• Each column (document) is a vector of word counts
  – But dimensionality is too high and vectors are sparse
    • Very difficult to cluster properly
  – Use principal component analysis (PCA) to reduce the dimension
  – In the new lower dimensional space, the latent factors are more like ‘topics’ - words and documents can correlate over the ‘topic factors’

• Assume that each document belongs to a single topic
• Can now cluster all documents and treat clusters as topics
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**Consensus – Results**

- Arrive at a distribution of documents over the topic clusters
  - E.g., 100 articles about sovereign debt, 300 about oil, ...
- Define *consensus* as the reciprocal of the *entropy*, we plot the entropy (yellow) and sentiment (black) below.

![Chart](chart.png)
Consensus – Results and Interpretation

- We emphasize that this is a measure of narrative consensus
  - Not necessarily equal to market consensus, presumably reflects what the public wants to read
  - But market consensus may also reflect what people read
- We find that consensus clearly increased 2005-2007, a period of ‘low levels of anxiety’ – reflecting the belief in a new paradigm
- May/June 2007 surge in anxiety, consensus increased further
  - Exploring sample documents from the largest cluster tells of
    - Economic uncertainty and bad credit conditions in Europe
- The crisis period that follows clearly stimulates new narratives
  - Perhaps because this provided an opportunity to write new stories!
  - Perhaps due to increased awareness of uncertainty
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Summary

• We have explored a measure of relative sentiment shifts and narrative consensus in a variety of data sources
  – Internal market commentary, broker reports, and news
• We have found
  – Relative sentiment correlates with significant financial events
  – Sentiment was very high and stable pre-crisis
  – BROKER can potentially be used to forecast MCI
  – MC&DAILY can potentially be used to forecast market volatility
  – The consensus metric gives an intuitive representation of the belief in a new financial paradigm pre-crisis
• We have thus found some evidence to support the use of these methods in policy to identify financial system risks and forecast developments in the financial system
Possible Extensions

• Analysis of new data sources, e.g.,
  – Sell side broker reports
  – corporate emails
  – financial news, …

• Further development of sentiment series
  – Possibly weighting the words

• Further development of consensus
  – Identification and visualisation of the narratives driving consensus

• More econometrics
  – Macro forecasting, we have some evidence linking relative sentiment to GDP (‘nowcasting’ and forecasting)
  – Financial forecasting, VIX?

• Comparison to other indicators?