Components of Uncertainty

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BI Norwegian Business School and Norges Bank
Introduction
1. What is the effect of elevated uncertainty on the economy?
   - Several studies document that an increase in uncertainty is followed by worsening economic conditions, see e.g. Bloom (Ecma, 2009), Jurado et al. (AER, 2015) and Baker et al. (QJE, 2016)

2. Do different types of uncertainty exist? If, so, how do the different types of uncertainty affect the economy?
   - Some types of uncertainty is suggested to have a positive effect on the economy. See, e.g. Segal et al. (JFE, 2015)
   - These theories are often referred to as “growth options” theories, and have been suggested as a driver of the dot-com boom in the late 1990s.
Measuring uncertainty

Uncertainty is hard to measure, and several proxies for uncertainty have been suggested:

1. Implied stock market volatility, e.g. Bloom (Ecma, 2009)
2. Time varying volatility, Fernández-Villaverde et al. (AER, 2011)
3. Forecast disagreement, e.g. Bachmann et al. (AEJ Macro, 2013)
4. The unforecastable component of a large set of macroeconomic indicators, e.g. Jurado et al. (AER, 2015)
5. **Uncertainty terms in newspapers**, e.g. Baker et al. (QJE, 2016)
1. Measures category-specific uncertainty
   - Using machine learning techniques, I create uncertainty measures based on the frequency of uncertainty terms in various types of news.
   - **Finding:** Identify several uncertainty measures with a clear interpretation such as Macroeconomics, Funding and Fiscal policy.

2. Identify distinct types of uncertainty
   - Extract orthogonal components from the various category specific measures
   - **Finding:** The orthogonal components are related to four uncertainty categories: (1) economic and financial distress, (2) the institutional framework of monetary policy, (3) relationship to the EU and (4) technology and firm expansion

3. Study the effect of the four orthogonal types of uncertainty on the economy
   - Estimate the effect of uncertainty shocks in a Structural VAR
   - **Finding:** The effect of uncertainty shock depends on the type of uncertainty.
Classifying the news
Classifying news articles

- Data: Dagens Næringsliv, Norway's biggest business newspaper and the fourth largest irrespective of theme.
  - The data spans 1988 – 2016
  - Close to 500,000 articles

- The newspaper is decomposed according to the topics it writes about using a topic model called Latent Dirichlet Allocation (LDA) model introduced by Blei, Jordan, and Ng (JMLR, 2003).

- The LDA takes a set of articles as input and return two sets of distributions:
  - One set of distributions over words, one distribution for each topic $j$, given by $\theta_j$
  - One set of distributions over topics, one distribution for each article $i$, given by $\varphi_i$
Estimating the topic model

- The researcher must select the number of topics prior to estimation:
  \[ \text{# topics} = 80 \]
- There is a trade-off between interpretable topics and how well the topics are at explaining the whole newspaper, see Chang et al. (NIPS, 2009).
- Estimation is done using MCMC
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Here are two examples of the topic distributions \( \theta_j \):

Macroeconomics \((j = 19)\)  
Monetary policy \((j = 72)\)
Category-specific uncertainty
The words that are counted: *uncertain* and *uncertainty* (and also variations of these words)

Let’s define

\[ \nu_i \equiv \text{number of uncertainty terms in article } i \]
\[ \omega_i \equiv \text{number of total words in article } i \]

I start by calculating an aggregate uncertainty measure:

\[
\text{Aggregate uncertainty on day } t = \sum_{i \in \text{day } t} \frac{\nu_i}{\omega_i}
\]
Aggregate uncertainty

*Note:* The 300 day backward-looking rolling mean is plotted. The series gives the share of uncertainty terms per 1 million words in the newspaper.
Classifying the news

The topic distributions are given by $\varphi_i$. Four example articles:

- "Interest rates down" - 21/10/1992
- "McCain" - 01/07/2008
- "Trippeled pension savings" - 14/09/2004
- "To little house construction" - 29/11/2010
The category specific uncertainty measures are calculated for all topics $j$:

$$\text{Topic } j \text{ uncertainty on day } t = \frac{\sum_{i \in \text{day}} t \upsilon_i \varphi_i(\text{topic } j)}{\sum_{i \in \text{day}} t \omega_i}$$
Topic specific uncertainty

Stock Market Uncertainty

- EU referendum
- 9/11
- Lehman
- Flash crash

Macroeconomic Uncertainty

- Bank bailout
- LTCM default
- Credit crunch
- OPEC meeting
Topic specific uncertainty

Monetary policy Uncertainty

- Stability t.w. EU
- Inflation target
- Lehman
- Greek prop. refer.

Oil price Uncertainty

- Gulf War 1
- Asia crisis
- Credit crunch
- OPEC meeting

Topic specific uncertainty

EU Uncertainty

USA Uncertainty

Word clouds
Components of uncertainty
Finding orthogonal components

- The 80 uncertainty measures often capture similar types of uncertainty.
- I extract orthogonal components of uncertainty by principal component analysis (PCA).
- Keep the components that explain 5 percent or more of the topic-based measures.
- Normalize the components according to the topic-based measure with the highest correlation.
The component measures

**Component 1**

**Component 2**

**Component 3**

**Component 4**

EV: 35% (35%)

EV: 15% (49%)

EV: 9% (58%)

EV: 6% (64%)
<table>
<thead>
<tr>
<th></th>
<th>economic and financial distress</th>
<th>instit. framework of mon. pol.</th>
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<tbody>
<tr>
<td></td>
<td>Correlation</td>
<td>Correlation</td>
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<tr>
<td>1st</td>
<td>Narrative</td>
<td>Monetary policy</td>
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<td></td>
<td>0.87</td>
<td>0.75</td>
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<td>Fear</td>
<td>Employment</td>
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<td>0.83</td>
<td>-0.56</td>
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<tr>
<td>3rd</td>
<td>Stock Market</td>
<td>Organizations</td>
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<tr>
<td></td>
<td>0.81</td>
<td>-0.56</td>
</tr>
<tr>
<td>4th</td>
<td>Statistics</td>
<td>Macroeconomics</td>
</tr>
<tr>
<td></td>
<td>0.81</td>
<td>-0.46</td>
</tr>
<tr>
<td>5th</td>
<td>Unknown</td>
<td>Weekdays</td>
</tr>
<tr>
<td></td>
<td>0.81</td>
<td>0.46</td>
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</table>

<table>
<thead>
<tr>
<th></th>
<th>relationship with the EU</th>
<th>tech. and firm expansion</th>
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<tbody>
<tr>
<td></td>
<td>Correlation</td>
<td>Correlation</td>
</tr>
<tr>
<td>1st</td>
<td>EU</td>
<td>Mergers &amp; Acquis.</td>
</tr>
<tr>
<td></td>
<td>0.85</td>
<td>0.55</td>
</tr>
<tr>
<td>2nd</td>
<td>Europe</td>
<td>Stock listings</td>
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<tr>
<td></td>
<td>0.72</td>
<td>0.55</td>
</tr>
<tr>
<td>3rd</td>
<td>Agriculture</td>
<td>IT systems</td>
</tr>
<tr>
<td></td>
<td>0.68</td>
<td>0.50</td>
</tr>
<tr>
<td>4th</td>
<td>Argumentation</td>
<td>Engineering</td>
</tr>
<tr>
<td></td>
<td>0.59</td>
<td>0.47</td>
</tr>
<tr>
<td>5th</td>
<td>Fiscal policy</td>
<td>Telecommunication</td>
</tr>
<tr>
<td></td>
<td>0.55</td>
<td>0.43</td>
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</tbody>
</table>
Uncertainty and the economy
A Structural VAR

I follow Baker et al. (QJE, 2016) and specify a structural VAR model where the identification is achieved using a Cholesky decomposition:

$$A_0 y_t = \sum_{j=1}^{3} A_j y_{t-j} + B\epsilon_t$$

where $y_t \equiv \begin{bmatrix} \text{Uncertainty} \\ \log(\text{OSEBX}) \\ \text{Interest rate} \\ \log(\text{Investments}) \\ \log(\text{GDP}) \end{bmatrix}$

the data sample is 1988Q2 – 2016Q4
Impulse responses from Comp. 1 and Comp. 2 shock economic and financial distress

instit. framework of monetary policy
Impulse responses from Comp. 3 and Comp. 4 shock relationship with the EU

technology and firm expansion
Conclusion
Summary

1. I have proposed a new method for constructing topic specific newspaper uncertainty
2. I have created 80 category specific measures of uncertainty for Norway based on the DN newspaper
3. Most topics have a clear interpretation
4. I extract four orthogonal components from the 80 topic-based measures
5. The effect of an uncertainty shock depends on the type of uncertainty
   5.1 A shock to Component 1, labeled as uncertainty related to economic and financial distress, yield an economic contraction in line with the uncertainty literature
   5.2 A shock to Component 4, labeled as uncertainty related to technology and firm expansion, yield a boom in GDP
The frequency of uncertainty terms in different types of news

<table>
<thead>
<tr>
<th>Top 10</th>
<th>words per 1 mil.</th>
<th>Bottom 10</th>
<th>words per 1 mil.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monetary policy</td>
<td>5.7</td>
<td>Drinks</td>
<td>0.9</td>
</tr>
<tr>
<td>Stock market</td>
<td>4.7</td>
<td>Movies/Theater</td>
<td>0.9</td>
</tr>
<tr>
<td>Macroeconomics</td>
<td>4.4</td>
<td>Food</td>
<td>1.0</td>
</tr>
<tr>
<td>Fear</td>
<td>3.7</td>
<td>Literature</td>
<td>1.0</td>
</tr>
<tr>
<td>Oil price</td>
<td>3.2</td>
<td>Music</td>
<td>1.0</td>
</tr>
<tr>
<td>Debate</td>
<td>2.9</td>
<td>Art</td>
<td>1.0</td>
</tr>
<tr>
<td>Negotiation</td>
<td>2.4</td>
<td>Sports</td>
<td>1.1</td>
</tr>
<tr>
<td>Results</td>
<td>2.4</td>
<td>Family business</td>
<td>1.1</td>
</tr>
<tr>
<td>Oil production</td>
<td>2.3</td>
<td>Watercraft</td>
<td>1.1</td>
</tr>
<tr>
<td>Elections</td>
<td>2.3</td>
<td>Tourism</td>
<td>1.1</td>
</tr>
</tbody>
</table>
### Component correlations with alternative measures

<table>
<thead>
<tr>
<th>Country</th>
<th>Component 1</th>
<th>Component 2</th>
<th>Component 3</th>
<th>Component 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Norway EPU</td>
<td>0.69</td>
<td>-0.16</td>
<td>0.25</td>
<td>-0.2</td>
</tr>
<tr>
<td>US VIX</td>
<td>0.66</td>
<td>-0.033</td>
<td>-0.24</td>
<td>0.33</td>
</tr>
<tr>
<td>US EPU</td>
<td>0.55</td>
<td>-0.59</td>
<td>-0.094</td>
<td>0.0053</td>
</tr>
<tr>
<td>JLN Finance</td>
<td>0.52</td>
<td>-0.06</td>
<td>-0.29</td>
<td>0.37</td>
</tr>
<tr>
<td>EU EPU</td>
<td>0.48</td>
<td>-0.41</td>
<td>-0.11</td>
<td>-0.4</td>
</tr>
<tr>
<td>JLN Macro</td>
<td>0.42</td>
<td>-0.28</td>
<td>-0.41</td>
<td>0.34</td>
</tr>
<tr>
<td>China EPU</td>
<td>0.41</td>
<td>-0.52</td>
<td>0.24</td>
<td>-0.32</td>
</tr>
<tr>
<td>RSMV</td>
<td>0.38</td>
<td>-0.33</td>
<td>-0.56</td>
<td>-0.19</td>
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<tr>
<td>UK EPU</td>
<td>0.27</td>
<td>-0.62</td>
<td>0.34</td>
<td>-0.49</td>
</tr>
</tbody>
</table>
Word clouds

Stock market ($j = 18$)

Macroeconomics ($j = 19$)
Monetary policy ($j = 72$)

Oil price ($j = 33$)
Word clouds

EU $(j = 25)$

USA $(j = 11)$