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Outline

- Introduction
- Measure and Data
- Empirical Analysis
- Robustness
- Discussion
- Conclusion
Introduction
Objective

In this paper, we

- Construct novel measures of oil industry uncertainty (OIU) based on forecasts of a large number of financial analysts
- Study the macroeconomic impact of OIU measures
- Explore possible sources of OIU
Oil Uncertainty measure in the literature

1. Oil price uncertainty, as in Elder and Serletis (2010), Kellogg (2014), Maghyereh et al. (2016), Yin and Feng (2019), among others

2. Unpredictability in oil variables, as in Jo (2014)

Advantages of our measure

1. Uncertainty in the form of an increase in the difficulty of analysts arriving at accurate or agreed forecasts

2. 12-months forecast horizon, likely to be a more relevant horizon for investment decisions and real activity
Findings

- Baseline OIU lowers US output and price level, and the federal funds rate.
- In the oil market, it lowers US oil production and oil price.
- The stock market responds slightly positively to OIU.
- OIU differs from aggregate uncertainty and other oil shocks identified in the literature, but correlated with technical change specific to the oil industry.
Measure and Data
Baseline Measure

- Use forecasts of earnings-per-share ratios (EPS) of individual companies in oil&gas sector.

- On each day, compute the average forecast error of all analysts for each firm.

\[
FE_{i,d} = \frac{1}{N_{i,d}} \sum_{j=1}^{N_{i,d}} \left\{ F[S_{i,d^*} | I_{j,d}] - S_{i,d^*} \right\}
\]

where \( i \) denotes firm, \( j \) denotes analyst, \( d \) denotes day

- Then for each month, compute the median of absolute forecast errors across all firms

\[
OIU_t = \text{median} \left\{ |FE_{i,d}| : \forall d \in [t, t + 1) \land N_{i,d} > 0, i \in \Upsilon \right\}
\]

where \( t \) denotes month, \( \Upsilon \) is the set of firms in the oil&gas producing sector.
Other Measures

- Relative OIU

\[
OIU_t = \frac{\text{median}\left\{ |FE_{i,d}| : \forall d \in [t, t+1) \land N_{i,d} > 0, i \in \Upsilon \right\}}{\text{median}\left\{ |FE_{i,d}| : \forall d \in [t, t+1) \land N_{i,d} > 0, i \notin \Upsilon \right\}}
\]

- OIU based on dispersion: For each firm \(i\) within each month \(t\), we compute

\[
D_{it} = \text{Disp}\left\{ F[S_{i,d^*} | l_{j,d}] : \forall d \in [t, t+1) \land N_{i,d} > 0 \right\}
\]

Then,

\[
OIU_t = \text{median}\left\{ D_{it} : i \in \Upsilon \right\}
\]
Daily EPS forecasts are drawn from the Institutional Brokers’ Estimate System dataset (I/B/E/S) to construct monthly uncertainty measure

- US firms
- 03/1982-12/2018
- 4.7 million forecasts by roughly 1,500 brokers
- 86% single forecasts per firm per day
- Deflate by security prices from CRSP dataset.
Compared to Aggregate Uncertainty

![Graph showing trends over time with peaks and troughs.](image-url)
Macroeconomic Impact
Baseline VAR

- Monthly data of

\[
\begin{bmatrix}
\log(S&P 500 \text{ Index}) \\
\text{oilindustryuncertainty} \\
\text{federal funds rate} \\
\log(CPI) \\
\log(\text{US oil production}) \\
\log(\text{US real activity}) \\
\log(\text{World oil production}) \\
\text{Worldrealactivity} \\
\log(\text{real oil price})
\end{bmatrix}
\]

- Similar with Bloom (2009) and Kilian (2009)
Macroeconomic Implications of OIU

Responses to Innovation in oil industry uncertainty, *Oil Uncertainty Shock*

![Graphs showing the responses to innovation in oil industry uncertainty.](image)

Ma & Samaniego (TTU & GWU)
Historical Decomposition: US Oil Production

US Oil Production

-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8

stock
oiluncertainty
ffr
cpi
USoilprod
USactivity
Worldoilprod
Worldactivity
oilprice

Ma & Samaniego (TTU & GWU)

Oil Industry Uncertainty

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Robustness
Variants of VAR Specification & OIU Measure

- Variants of VAR specification
  1. Changing the ordering of uncertainty
  2. Using 13 lags and 24 lags
  3. HP-filtering or log-differencing all variables
  4. Excluding post-2007 observations

- Variants of uncertainty measure
  1. Measures based on interquartile and standard deviation
  2. Measures with various forecast horizons

- Variants of identification
  1. VAR with oil inventories
  2. VAR with the world production index constructed by Baumeister and Hamilton (2019)
Impulse Responses to Oil and Non-Oil Uncertainty Shocks

Stock Market to Oil U

Stock Market to Non-Oil U

US Real Activity to Oil U

US Real Activity to Non-Oil U

US Oil Prod to Oil U

US Oil Prod to Non-Oil U

World Oil Prod to Oil U

World Oil Prod to Non-Oil U

World Real Activity to Oil U

World Real Activity to Non-Oil U

Real Oil Price to Oil U

Real Oil Price to Non-Oil U
Table 1: Forecast Variance Due to Oil and Non-Oil Uncertainty (in percent)

<table>
<thead>
<tr>
<th>Horizon</th>
<th>US oil prod</th>
<th>World oil prod</th>
<th>US activity</th>
<th>World activity</th>
<th>Oil price</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Oil</td>
<td>Non-Oil</td>
<td>Oil</td>
<td>Non-Oil</td>
<td>Oil</td>
</tr>
<tr>
<td>$h = 3$</td>
<td>10.98</td>
<td>0.10</td>
<td>0.09</td>
<td>0.45</td>
<td>3.91</td>
</tr>
<tr>
<td>$h = 12$</td>
<td>31.96</td>
<td>0.44</td>
<td>1.77</td>
<td>0.57</td>
<td>8.44</td>
</tr>
<tr>
<td>$h = 36$</td>
<td>20.25</td>
<td>3.30</td>
<td>2.70</td>
<td>0.97</td>
<td>3.21</td>
</tr>
<tr>
<td>$h = 60$</td>
<td>17.86</td>
<td>3.02</td>
<td>2.48</td>
<td>1.14</td>
<td>2.32</td>
</tr>
</tbody>
</table>
Impulse Responses to Oil and Aggregate Uncertainty Shocks

- Stock Market to Oil U
- Stock Market to Aggreg U
- US Real Activity to Oil U
- US Real Activity to Aggreg U
- US Oil Prod to Oil U
- US Oil Prod to Aggreg U
- World Oil Prod to Oil U
- World Oil Prod to Aggreg U
- World Real Activity to Oil U
- World Real Activity to Aggreg U
- Real Oil Price to Oil U
- Real Oil Price to Aggreg U
Table 2: Forecast Variance Due to Oil and Aggregate Uncertainty (in percent)

<table>
<thead>
<tr>
<th>Horizon</th>
<th>US oil prod</th>
<th>World oil prod</th>
<th>US activity</th>
<th>World activity</th>
<th>Oil price</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Oil Aggr</td>
<td>Oil Aggr</td>
<td>Oil Aggr</td>
<td>Oil Aggr</td>
<td>Oil Aggr</td>
</tr>
<tr>
<td>$h = 3$</td>
<td>10.44 0.14</td>
<td>0.08 0.12</td>
<td>3.11 9.16</td>
<td>0.22 2.80</td>
<td>6.35 1.10</td>
</tr>
<tr>
<td>$h = 12$</td>
<td>26.59 8.89</td>
<td>1.87 4.63</td>
<td>5.11 40.87</td>
<td>1.35 12.87</td>
<td>6.34 11.94</td>
</tr>
<tr>
<td>$h = 36$</td>
<td>18.22 16.00</td>
<td>2.69 3.47</td>
<td>2.32 25.94</td>
<td>1.36 10.79</td>
<td>5.48 12.17</td>
</tr>
<tr>
<td>$h = 60$</td>
<td>15.48 15.17</td>
<td>2.44 3.08</td>
<td>3.43 19.33</td>
<td>1.21 9.99</td>
<td>4.77 10.18</td>
</tr>
</tbody>
</table>
Relative Oil Uncertainty

Historical Time Series of Relative Oil Uncertainty
Impulse Responses to Relative Oil Uncertainty Shocks

- Federal Funds Rate
- US Real Activity
- S&P 500 Index
- World Real Activity
- US Oil Production
- World Oil Production
- Price Level
- Real Oil Price

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Discussion
What does OIU pick up? I

- We include oil market variables and aggregate uncertainty in the VAR, so that oil uncertainty shocks are orthogonal to oil shocks and aggregate uncertainty shocks.
- We calculate the contemporaneous correlation between oil uncertainty shocks and oil and aggregate uncertainty shocks in the literature.
- We also calculate whether those shocks granger cause oil uncertainty shocks.
Contemporaneous correlation

Table 3: Correlations of Oil Uncertainty Shocks with Other Shocks

<table>
<thead>
<tr>
<th>Oil Shock and Uncertainty Shock</th>
<th>Oil Uncertainty Shock</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil supply</td>
<td>0.031 (0.030)</td>
</tr>
<tr>
<td>Economic activity</td>
<td>-0.138 (0.080)</td>
</tr>
<tr>
<td>Oil specific demand</td>
<td>-0.033 (0.021)</td>
</tr>
<tr>
<td>Oil speculative demand</td>
<td>-0.165 (0.160)</td>
</tr>
<tr>
<td>Aggregate uncertainty</td>
<td>-0.008 (0.043)</td>
</tr>
</tbody>
</table>
Table 4: p-Values of the Granger Causality Test

<table>
<thead>
<tr>
<th>Specification</th>
<th>Oil Unc</th>
<th>Non-Oil Unc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil supply</td>
<td>0.34</td>
<td>0.06</td>
</tr>
<tr>
<td>Economic activity</td>
<td>0.16</td>
<td>0.53</td>
</tr>
<tr>
<td>oil specific demand</td>
<td>0.16</td>
<td>0.75</td>
</tr>
<tr>
<td>oil speculative demand</td>
<td>0.27</td>
<td>0.44</td>
</tr>
<tr>
<td>aggregate uncertainty</td>
<td>0.06</td>
<td>0.00</td>
</tr>
</tbody>
</table>
What does OIU pick up? II

- Negative aggregate demand shock
- Positive oil supply shock: technical change in the oil industry
- We measure technical progress using the stock of patents related to the oil industry:
  \[ P_{t+1} = a_t + P_t(1 - \delta) \]
- The stock of oil patents and OIU have a significant correlation of 0.2, and the highest correlation is 0.24 between the oil technology series and OIU 7 months later

<table>
<thead>
<tr>
<th>Table 5: p-Values of the Granger Causality Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specification</td>
</tr>
<tr>
<td>p-value</td>
</tr>
</tbody>
</table>
Conclusion

- We construct measures of oil industry uncertainty measure using micro level financial forecasts based on I/B/E/S survey data.

- OIU has unique implications for oil market and aggregate dynamics. The results are robust to various VAR specification/POIU measures.

- Oil uncertainty shocks could capture aggregate uncertainty and technology advancements in oil & gas sector.

- Future work: structural quantitative model where uncertainty originates in the oil industry.
THANK YOU!
Responses to Uncertainty Measured as Interquartile

Federal Funds Rate

US Real Activity

S&P 500 Index

World Real Activity

US Oil Production

World Oil Production

Price Level

Real Oil Price
Responses to Uncertainty Measured as Standard Deviation

- Federal Funds Rate
- US Real Activity
- S&P 500 Index
- World Real Activity
- US Oil Production
- World Oil Production
- Price Level
- Real Oil Price

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Responses to Uncertainty Measured based on 1Q Forecast Horizon

- Federal Funds Rate
- US Real Activity
- S&P 500 Index
- World Real Activity
- US Oil Production
- World Oil Production
- Price Level
- Real Oil Price
Responses to Uncertainty Measured based on 2Q Forecast Horizon

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Responses to Uncertainty Measured based on 3Q Forecast Horizon

Federal Funds Rate

US Real Activity

S&P 500 Index

World Real Activity

US Oil Production

World Oil Production

Price Level

Real Oil Price