The Macroeconomic Impact of Oil Industry Uncertainty: New Evidence from Millions of Financial Analyst Forecasts

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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

Feature

- 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.

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

where i denotes firm, j denotes analyst, d denotes day

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

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

where t denotes month, Υ is the set of firms in the oil&gas producing sector.

Other Measures

- Relative OIU

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

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

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

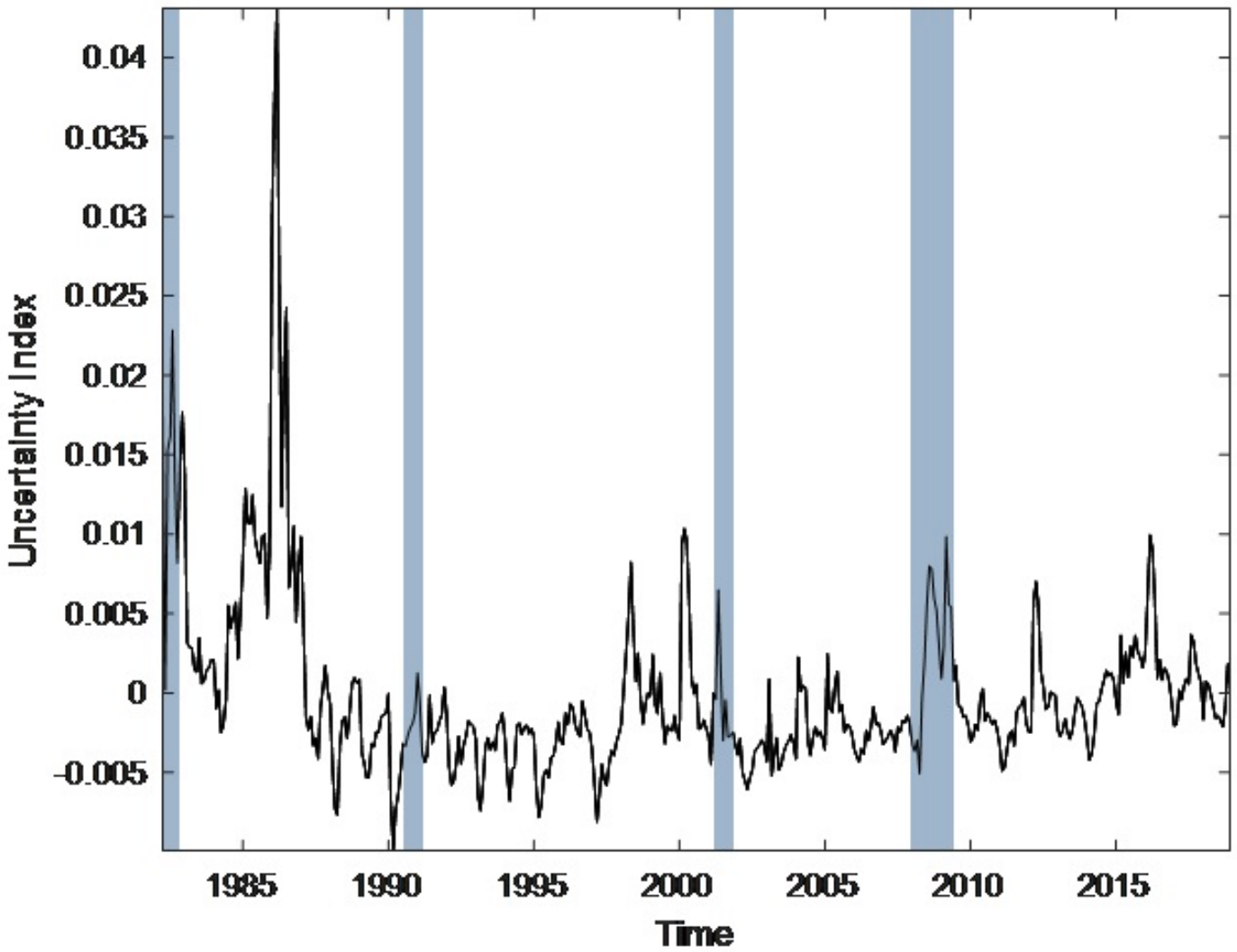
- Then,

$$OIU_t = \text{median}\left\{ D_{it} : i \in \Upsilon \right\}$$

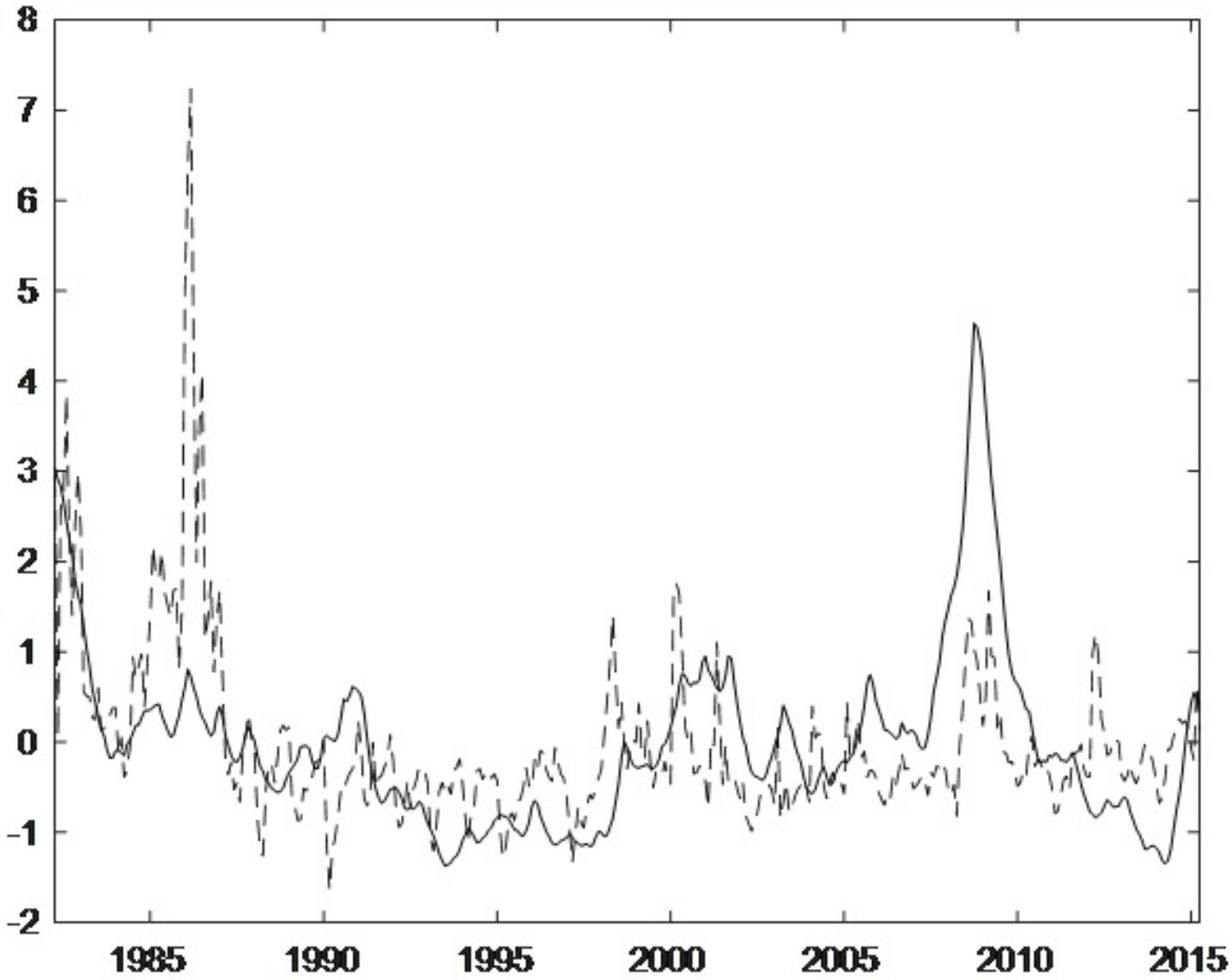
Data

- 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.

Historical Uncertainty Series



Compared to Aggregate Uncertainty



Macroeconomic Impact

Baseline VAR

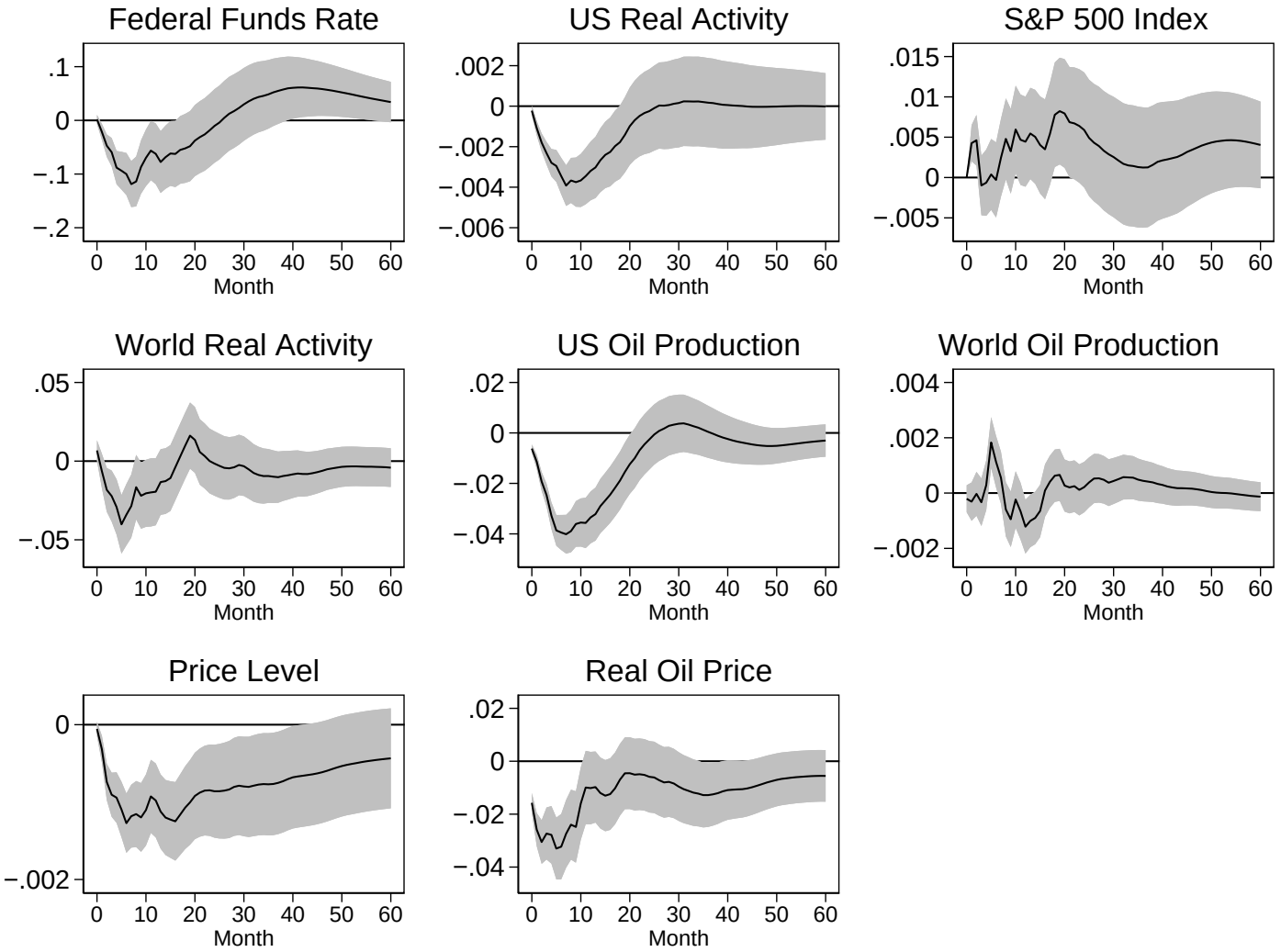
- Monthly data of

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

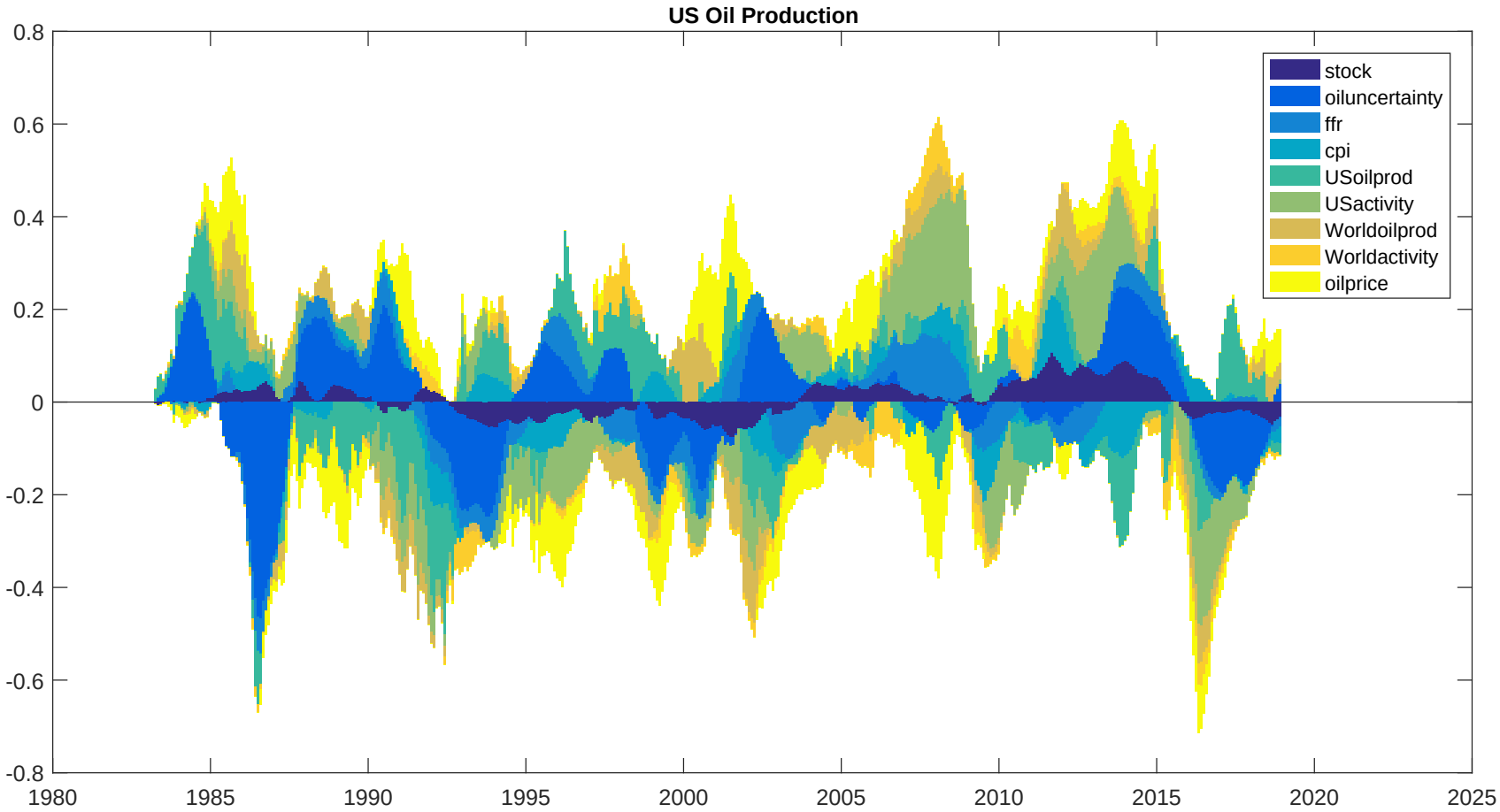
- Similar with Bloom (2009) and Kilian (2009)

Macroeconomic Implications of OIU

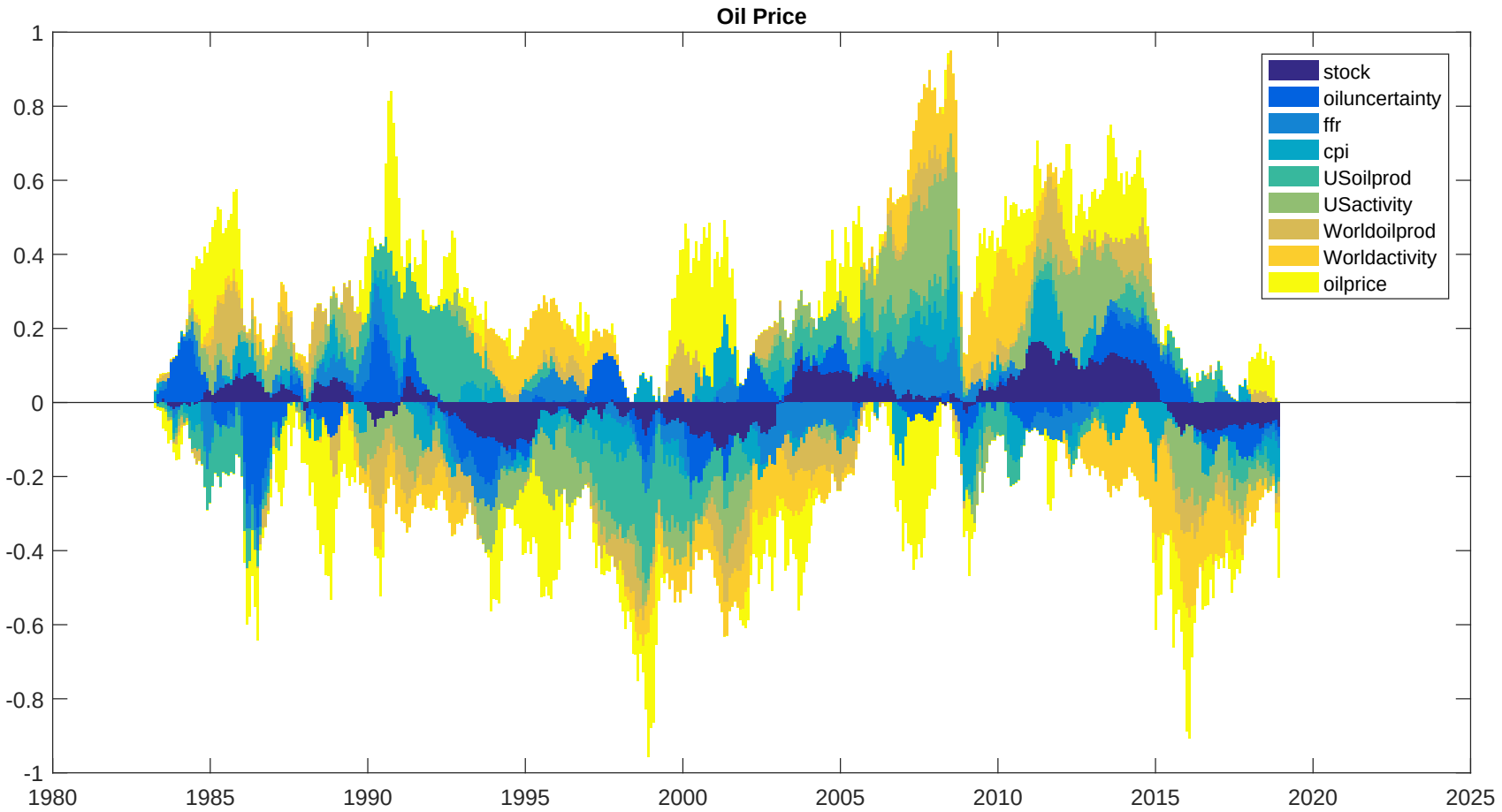
Responses to Innovation in oil industry uncertainty, *Oil Uncertainty Shock*



Historical Decomposition: US Oil Production



Historical Decomposition: Oil Price



Robustness

Variants of VAR Specification & OIU Measure

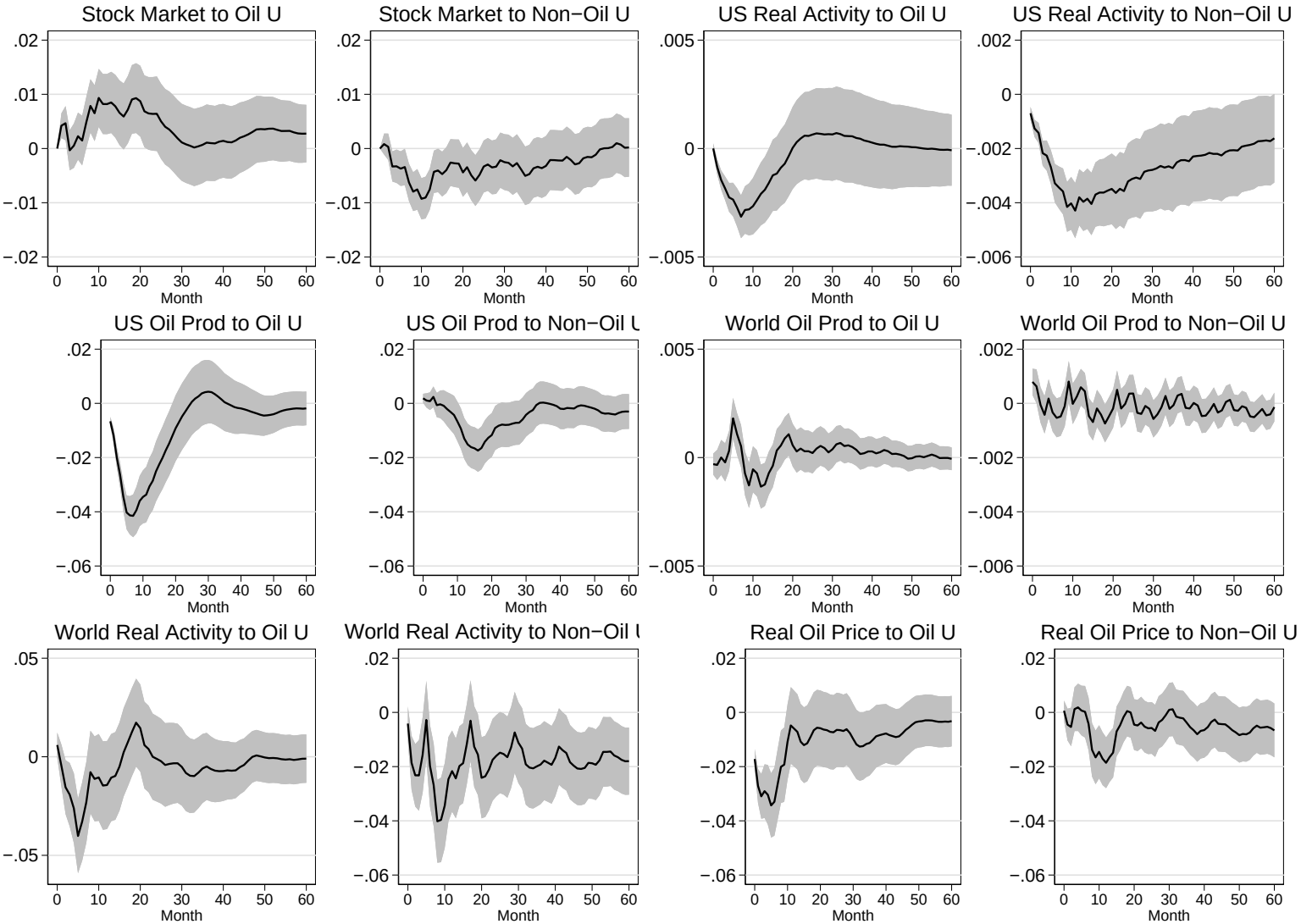
- Variants of VAR specification
  1. Changing the ordering of uncertainty
  2. Using 13 lags and 24 lags
  3. HP-filtering or log-differencing all variables
  4. Excluding post-2007 observations

- Variants of uncertainty measure Selected Robustness
  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)

Oil and Non-Oil Uncertainty I

Impulse Responses to Oil and Non-Oil Uncertainty Shocks



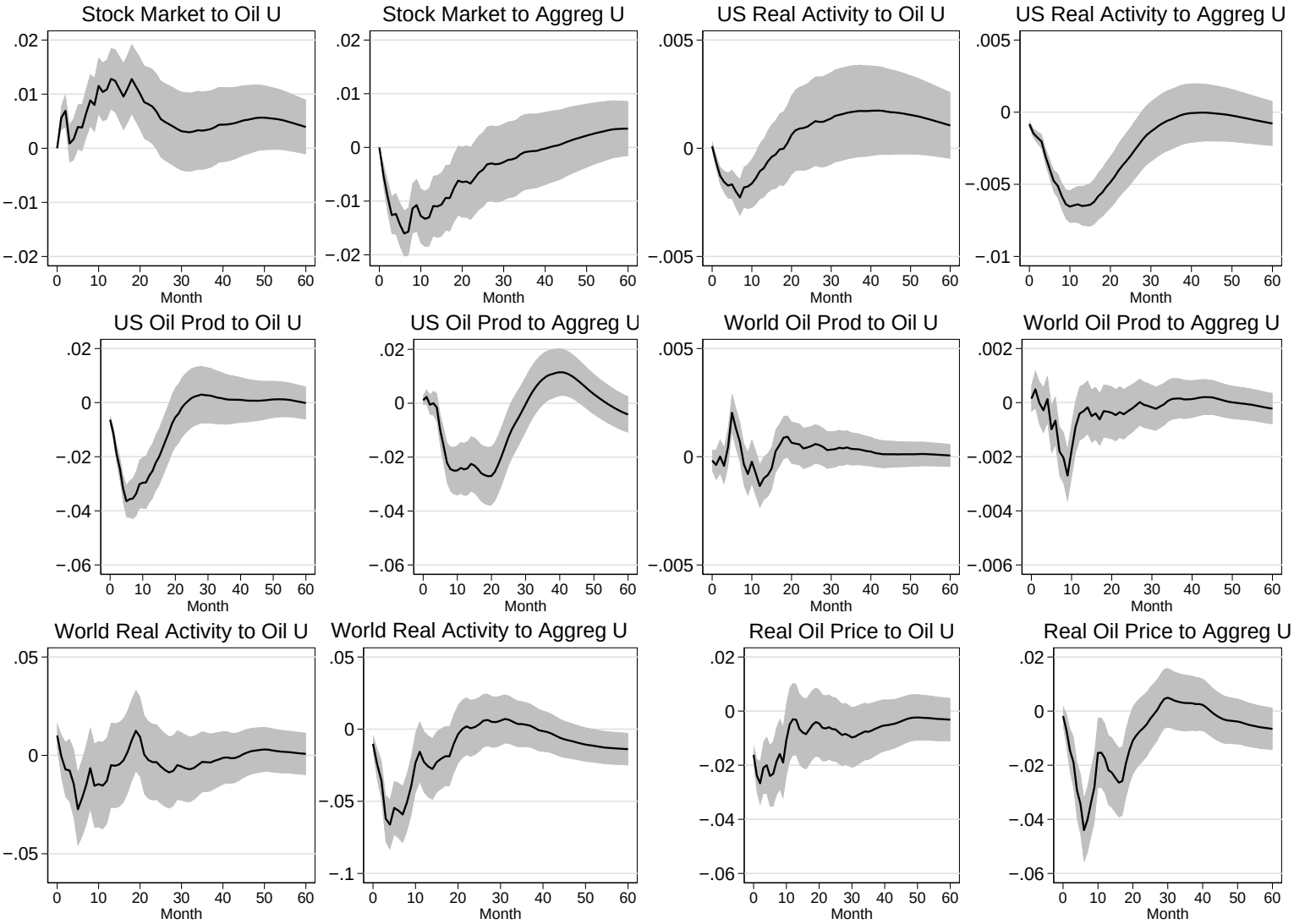
Oil and Non-Oil Uncertainty II

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

Horizon	**US oil prod**		**World oil prod**		**US activity**		**World activity**		**Oil price**	
	Oil	Non-Oil	Oil	Non-Oil	Oil	Non-Oil	Oil	Non-Oil	Oil	Non-Oil
$h = 3$	10.98	0.10	0.09	0.45	3.91	5.68	0.44	1.34	7.89	0.20
$h = 12$	31.96	0.44	1.77	0.57	8.44	14.56	2.56	3.91	9.75	1.33
$h = 36$	20.25	3.30	2.70	0.97	3.21	14.36	2.21	4.95	7.45	1.72
$h = 60$	17.86	3.02	2.48	1.14	2.32	13.24	2.01	6.33	6.51	1.92

Oil and Aggregate Uncertainty I

Impulse Responses to Oil and Aggregate Uncertainty Shocks



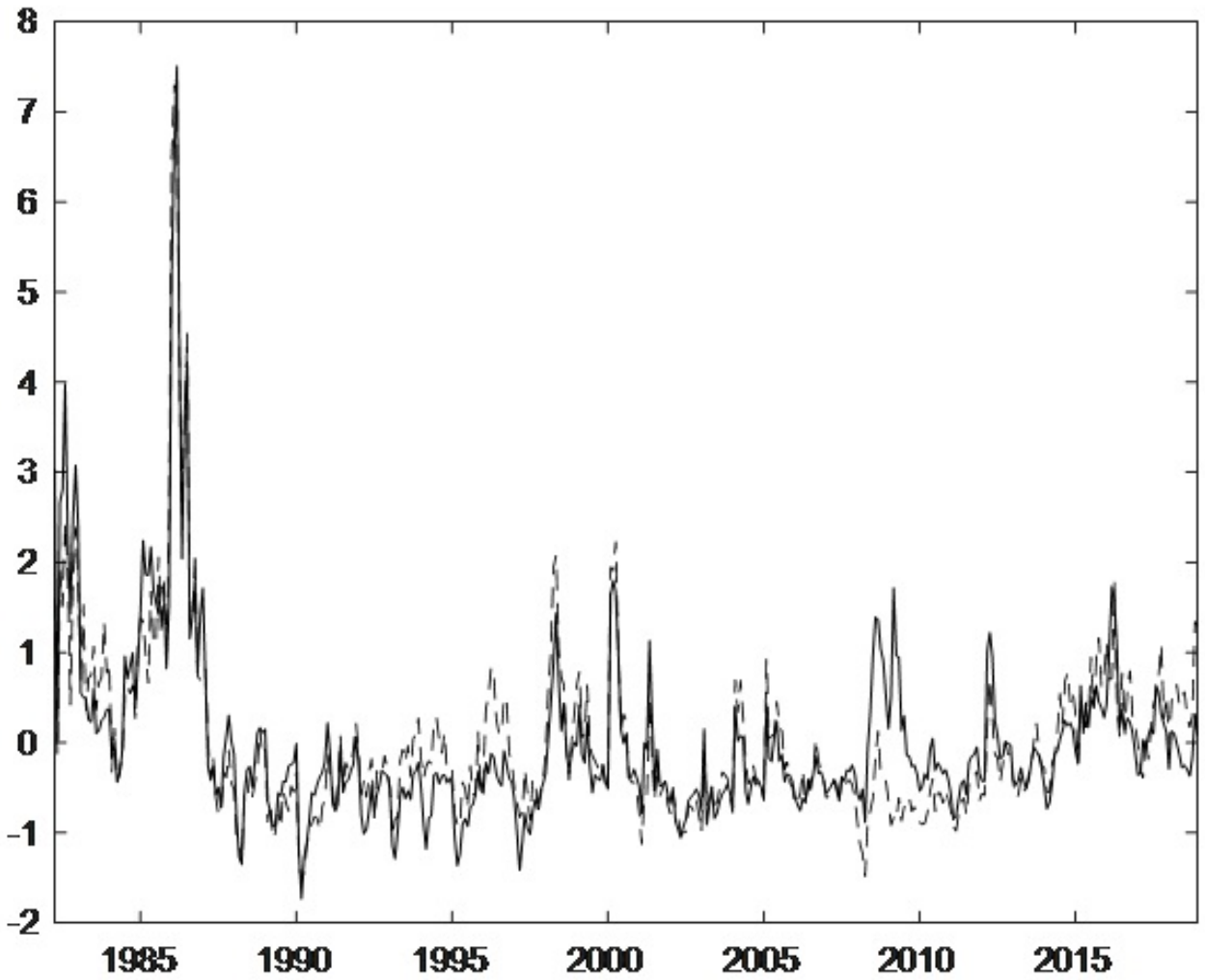
Oil and Aggregate Uncertainty II

Table 2: Forecast Variance Due to Oil and Aggregate Uncertainty (in percent)

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

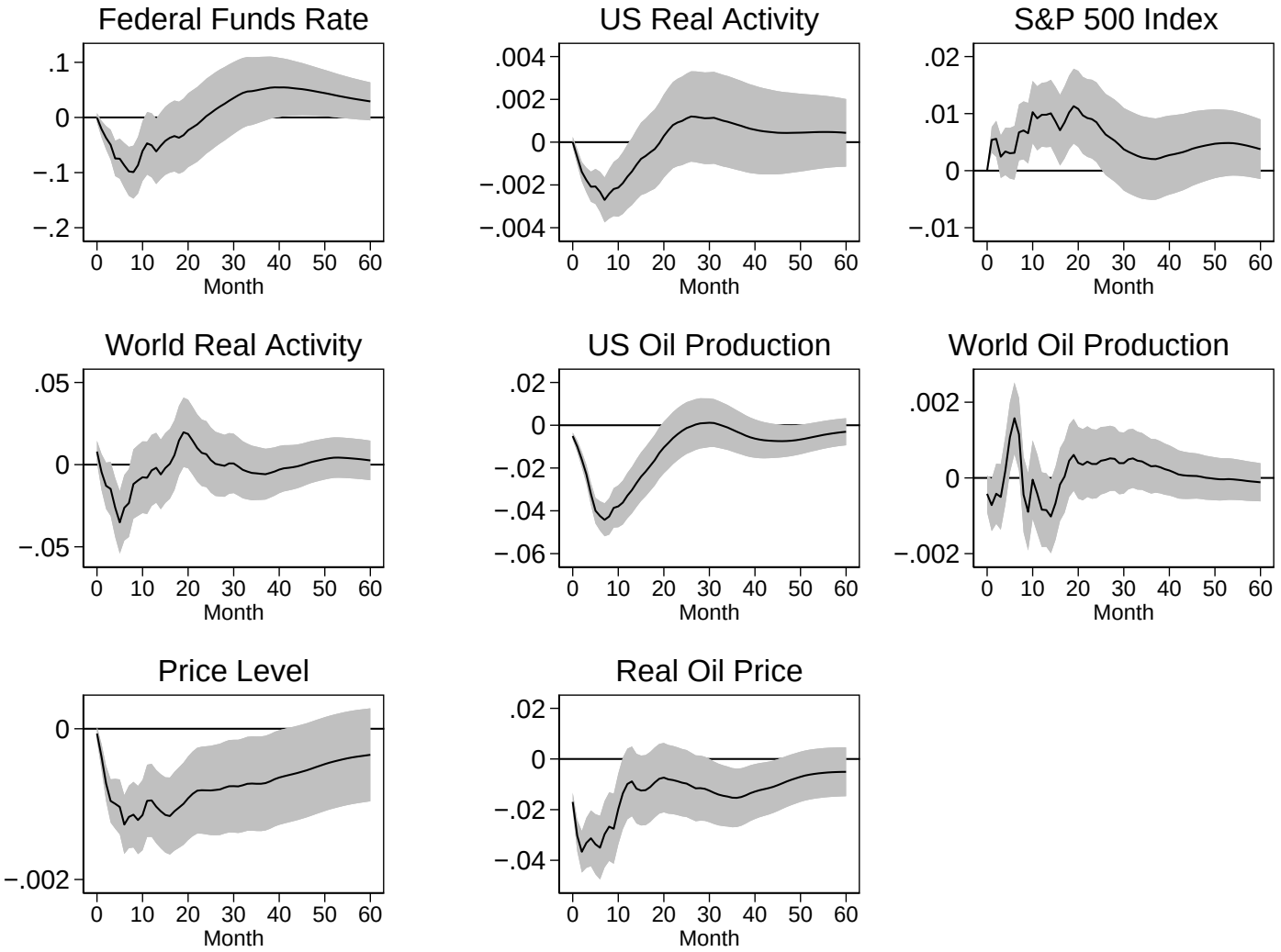
Relative Oil Uncertainty I

Historical Time Series of Relative Oil Uncertainty



Relative Oil Uncertainty II

Impulse Responses to Relative Oil Uncertainty Shocks



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

Oil Shock and Uncertainty Shock	**Oil Uncertainty Shock**
Oil supply	0.031(0.030)
Economic activity	-0.138(0.080)
Oil specific demand	-0.033(0.021)
Oil speculative demand	-0.165 (0.160)
Aggregate uncertainty	-0.008(0.043)

Lagged correlation

Table 4: p-Values of the Granger Causality Test

Specification	**Oil Unc**	**Non-Oil Unc**
Oil supply	0.34	0.06
Economic activity	0.16	0.53
oil specific demand	0.16	0.75
oil speculative demand	0.27	0.44
aggregate uncertainty	0.06	0.00

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 5: p-Values of the Granger Causality Test

Specification	**Oil patents**	**Non-Oil patents**
p-value	0.07	0.67

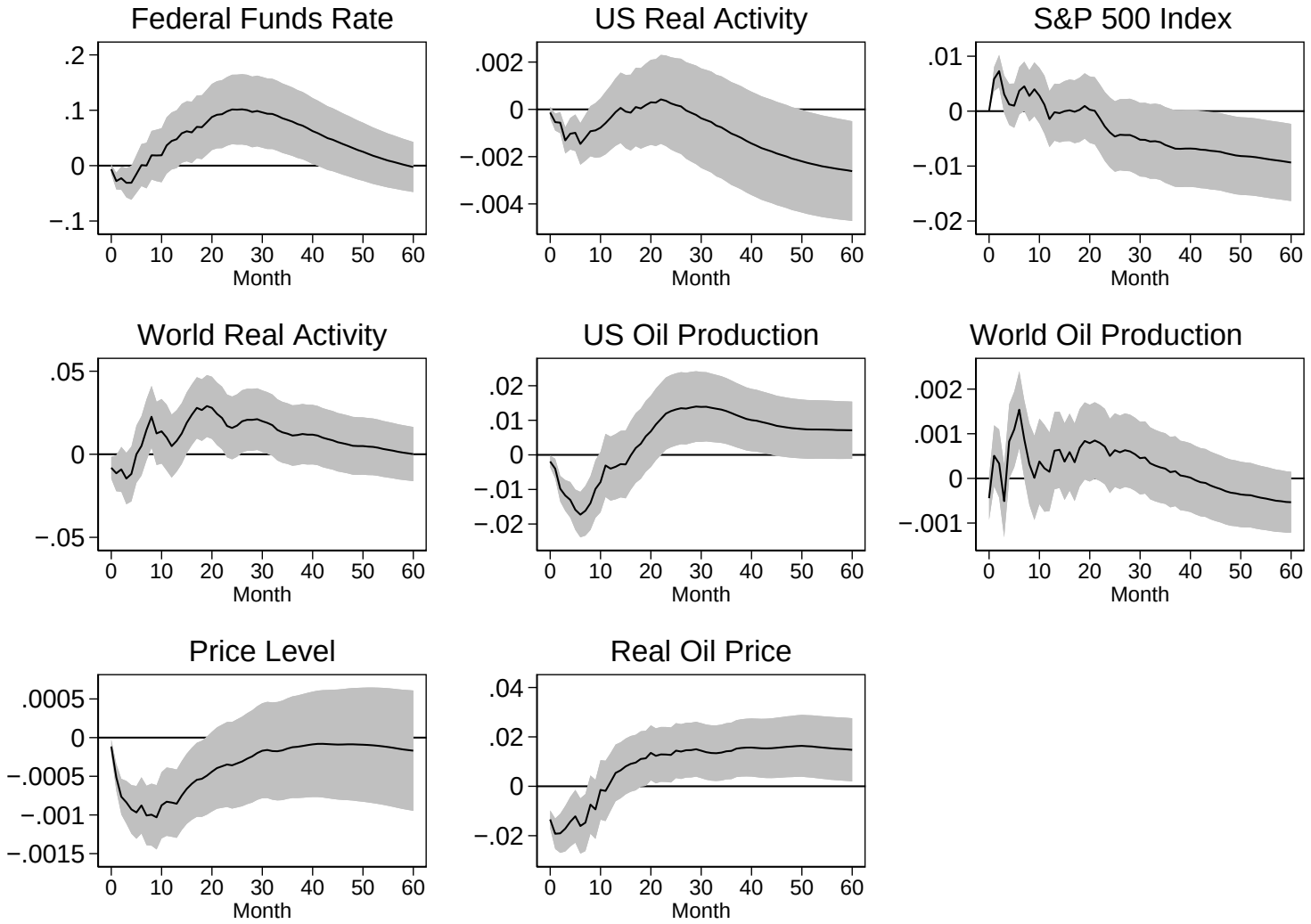
Conclusion

- 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/OIU measures.
- Oil uncertainty shocks could capture aggregate uncertainty and technology advancement in oil& gas sector.
- Future work: structural quantitative model where uncertainty originates in the oil industry.

THANK YOU!

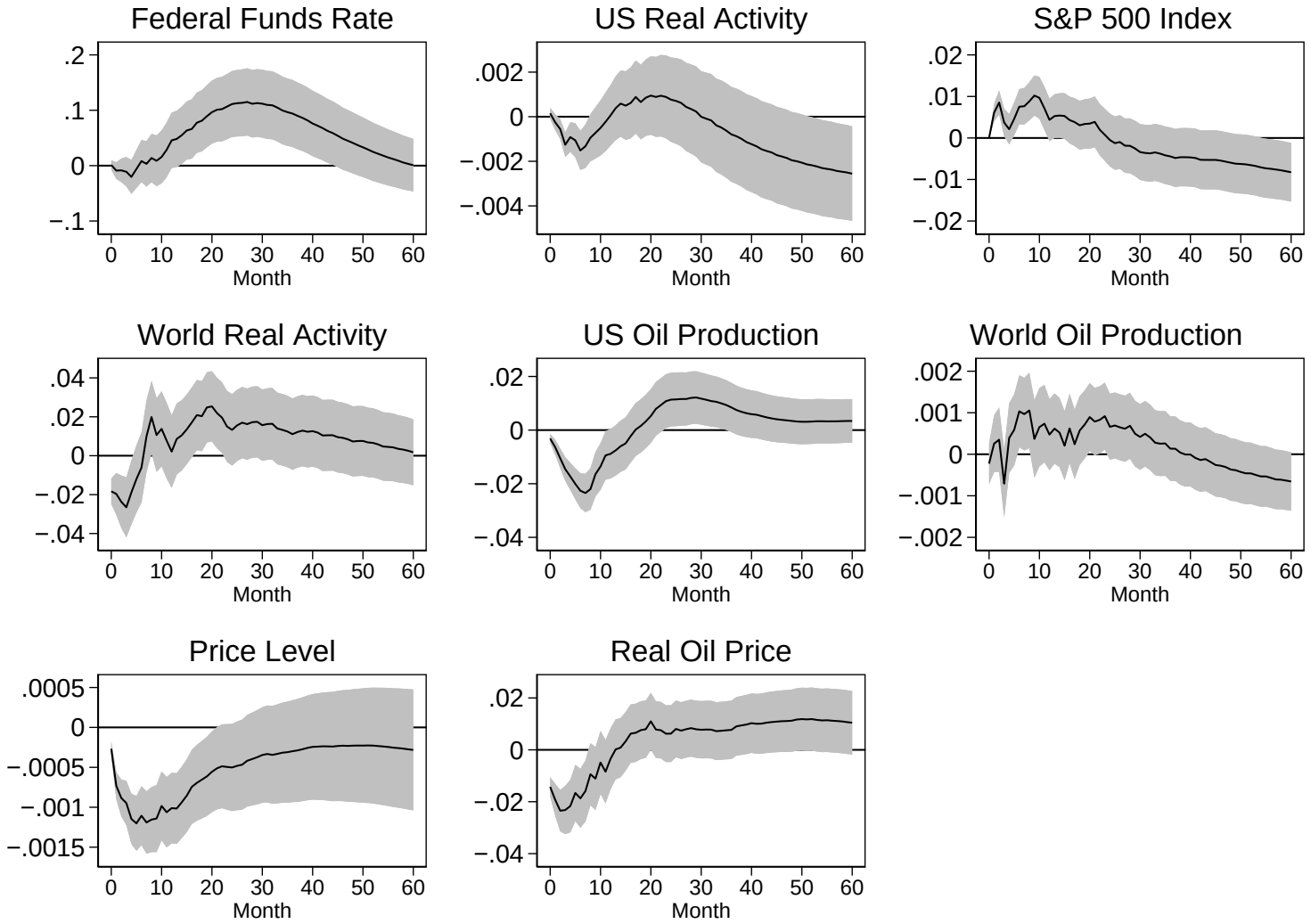
Alternative OIU Measures I

Responses to Uncertainty Measured as Interquartile



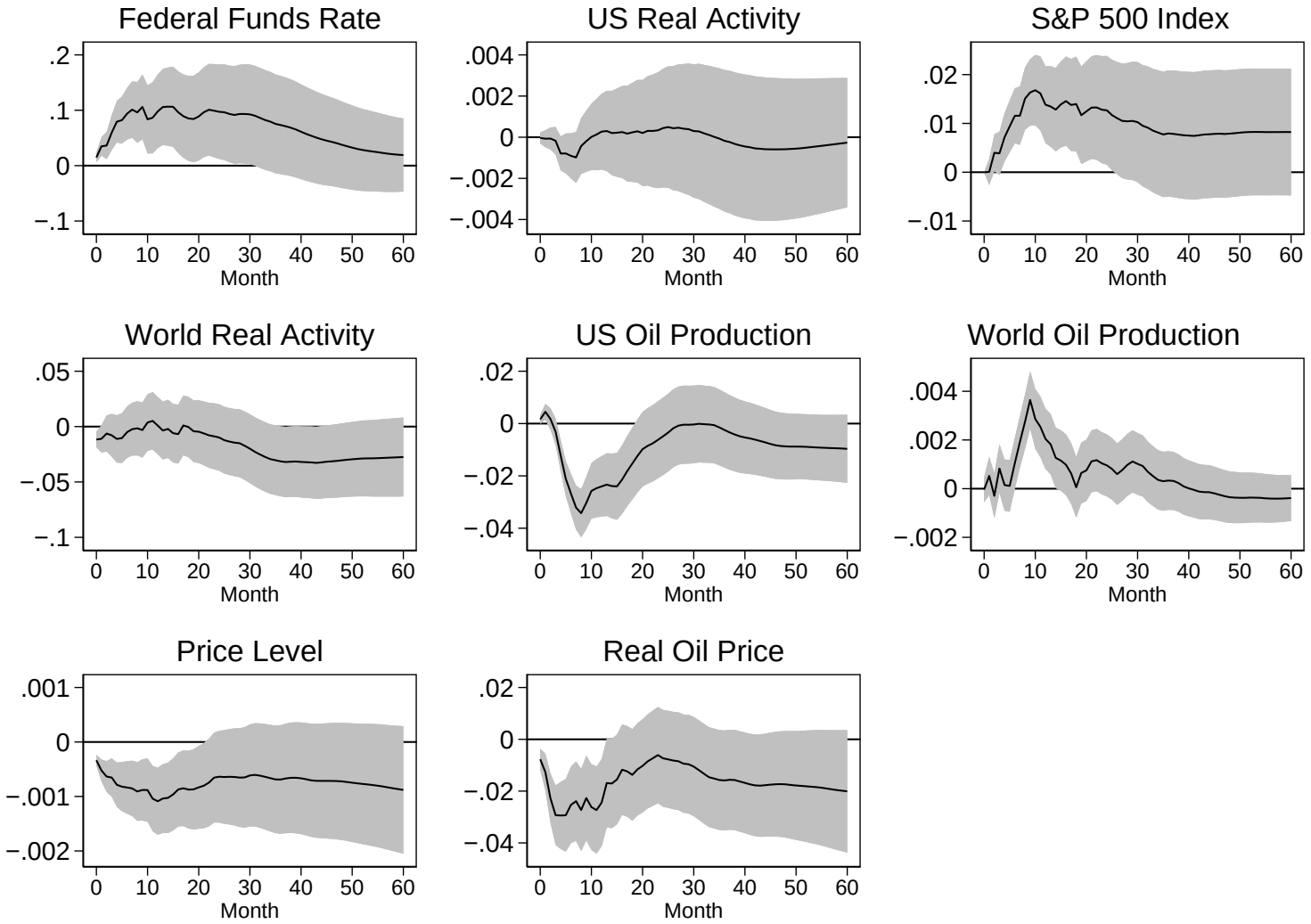
Alternative OIU Measures II

Responses to Uncertainty Measured as Standard Deviation



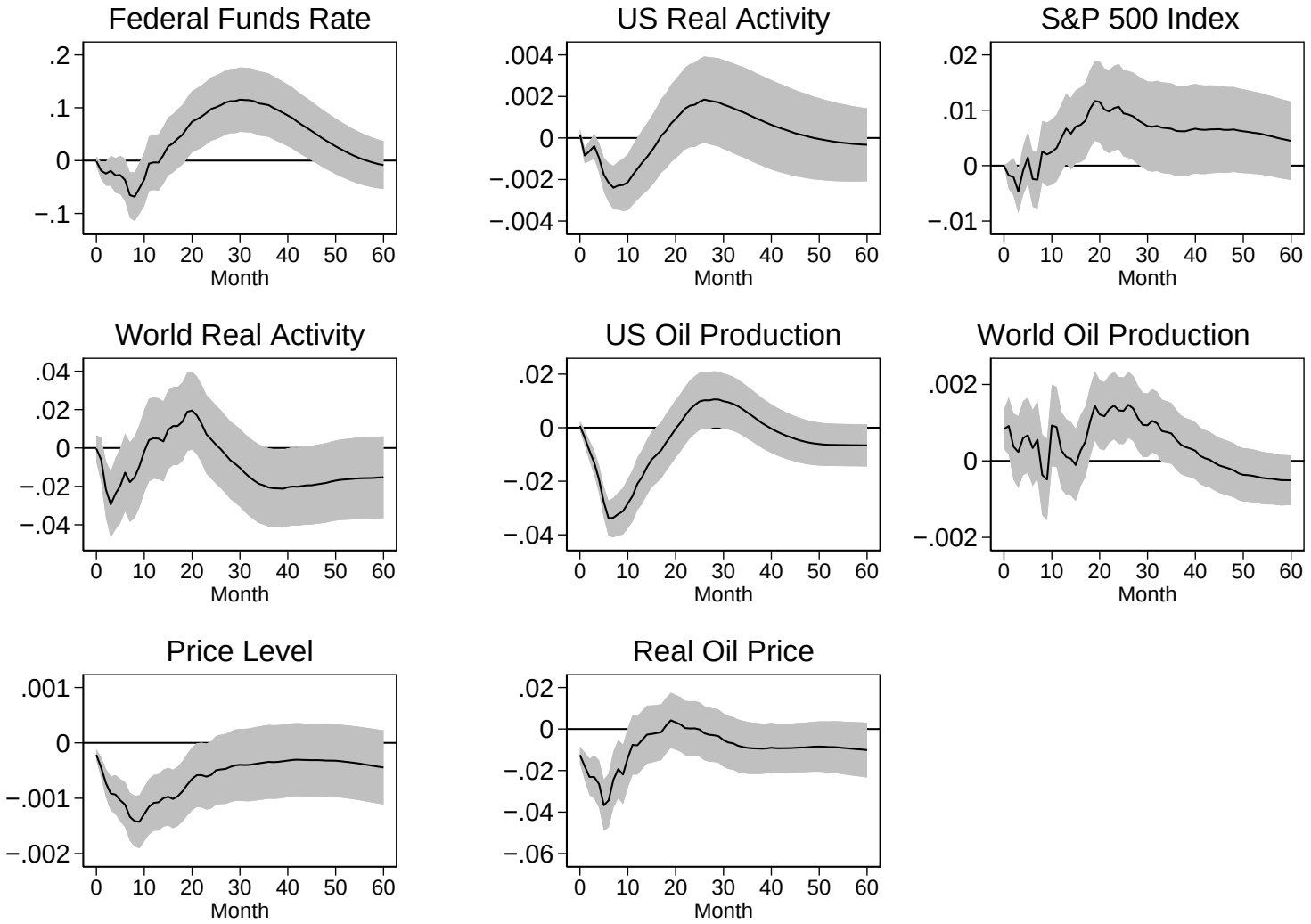
Alternative OIU Measures III

Responses to Uncertainty Measured based on 1Q Forecast Horizon



Alternative OIU Measures IV

Responses to Uncertainty Measured based on 2Q Forecast Horizon



Alternative OIU Measures V

Return

Responses to Uncertainty Measured based on 3Q Forecast Horizon