

Oil price elasticities and oil price fluctuations

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Workshop on Financial and Physical Oil Market Linkages

Low Oil Prices: Causes, Consequences, and Duration

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The views in this paper are solely our responsibility and should not be interpreted as reflecting the views of the Federal Reserve Board, or the Federal Reserve System in general.

Introduction

- Large swings in oil prices over last decade:
 - Run-up to \$140 per barrel through August 2008
 - Subsequent decline to \$40 per barrel through Great Recession
 - 65% decline from June 2014 to December 2015
- Two recurrent issues in the literature:
 - Nature of oil price shocks
 - Effects of oil price shocks
- **This paper:** New evidence on causes and consequences of oil price fluctuations b/w 1985-2015.

Methodology and Preview of Results

- Structural VAR to analyze sources and macroeconomic effects of oil price movements
- Novel data and identification to disentangle supply and demand shocks:
 - **Joint** restrictions on supply and demand elasticities;
 - **Multiple** indicators for global oil demand.
- Main findings:
 - Supply shocks:
 - Main drivers of oil prices;
 - **Boost/Depress** activity in **advanced/emerging** economies;
- **Key Takeaway:**
 - Selection of supply and demand elasticities is important for inference.

Measuring global demand for oil

Coincident Indicator: Industrial Production

- Requirements for global economic indicators:
 - Capture key features of global business cycle;
 - Have explanatory power for oil prices.
- Construct IP indexes for advanced and emerging economies (90% global GDP):
 - Reliable and widely available business cycle indicator;
 - Oil important input in industrial sector;
 - Advanced economies net oil importers;
 - Emerging economies oil independent (as a whole) and higher oil intensity.

Measuring global demand for oil

Leading Indicator: Metal Prices

- IMF Metal Price Index.
 - Metals crucial inputs in many industrial sectors.
- Captures shifts in current and expected global activity:
 - Academic literature
Pindyck & Rotemberg (1990); Labys & al. (1999), Barsky & Kilian (2001).
 - Popular blog entries
Arezki and Blanchard (2014), Hamilton (2014), Bernanke (2016).
- Results from **forecasting regressions**:
 - Metal prices help predict global activity and oil prices.

VAR Model

- VAR model of oil market and global economy with 5 variables (Jan 1985 - Dec 2015):
 - IP for advanced economies;
 - IP for emerging economies;
 - IMF metal price index;
 - Brent price of crude oil (deflated by U.S. CPI);
 - Global supply of crude oil.
- Identification: **Both** numerical and exclusion restrictions
- Disentangling oil market-specific shocks:
 - Key role of *joint numerical* restrictions on supply and demand elasticities

Identification of the VAR

Numerical Restrictions on Oil Market Elasticities

- A simple 2-equation model of the oil market:

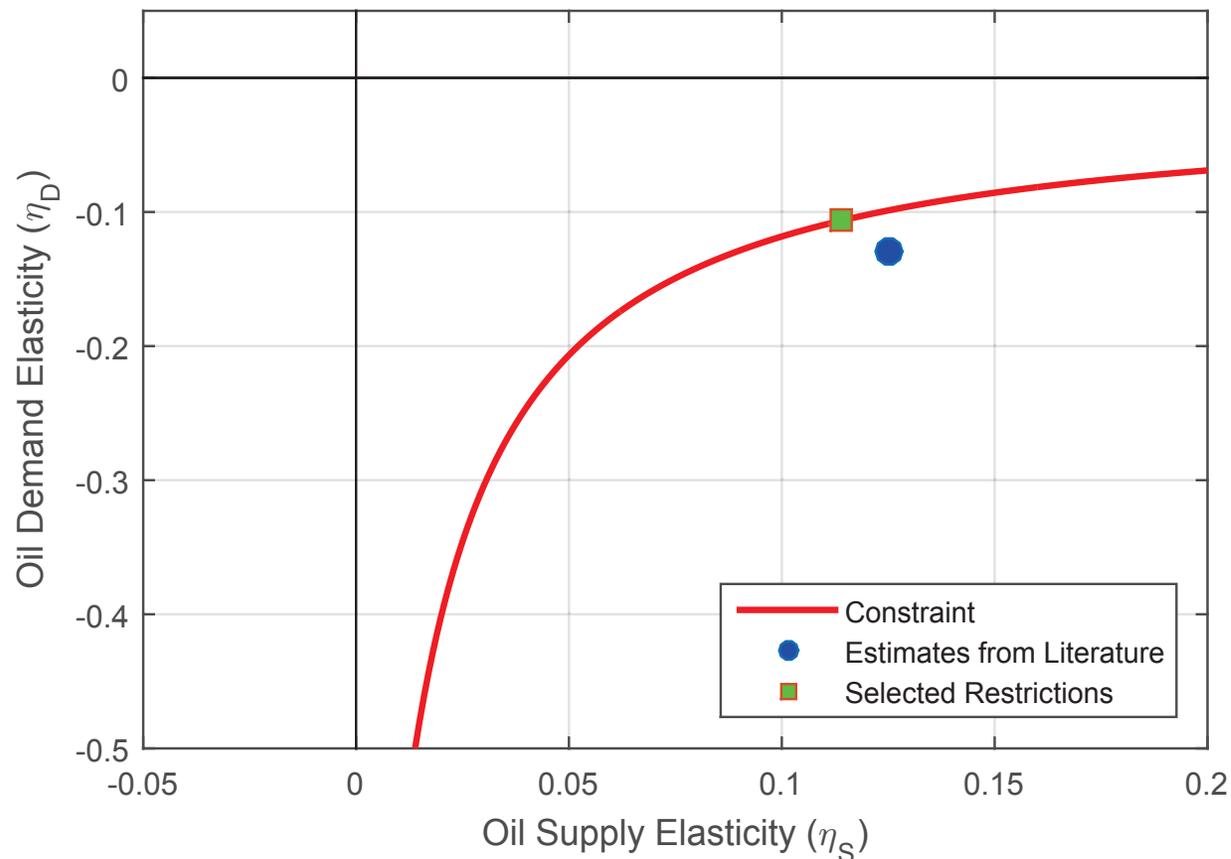
$$q_t = \eta_S p_t + u_{s,t},$$

$$q_t = \eta_D p_t + u_{d,t}.$$

- **Consensus** is that η_S and η_D both small:
 - Estimates from meta-analysis: $\eta_S = 0.13$; $\eta_D = -0.13$;
 - η_S possibly even smaller: 0.02.
Kilian & Murphy(2012)
- Insight from analytics of structural VARs:
 - VCV matrix of VAR residuals and restriction on supply elasticity imply value for demand elasticity (or vice versa).

Identification of the VAR

VAR-Implied Supply and Demand Elasticities



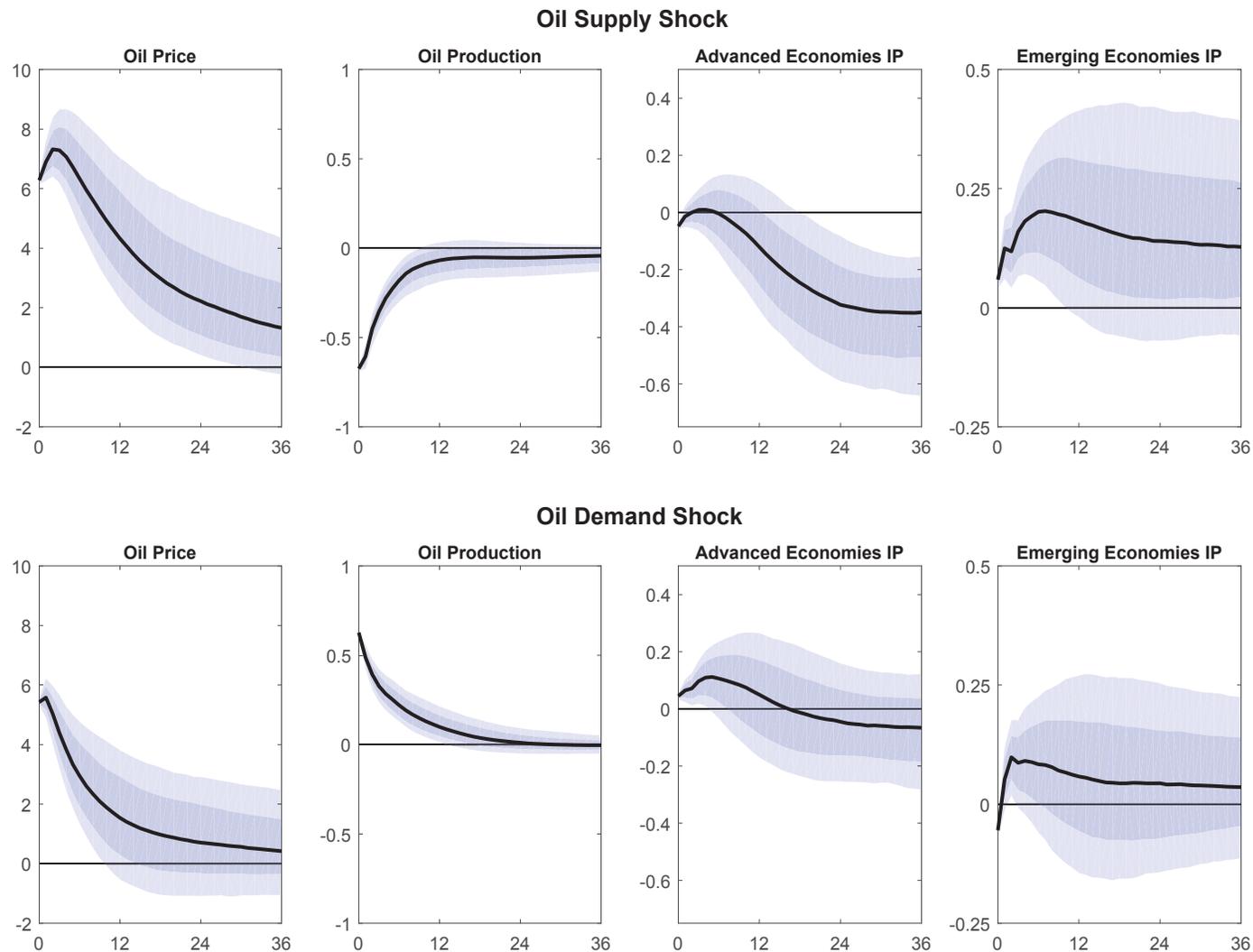
- Minimizing Euclidean distance b/w VAR-admissible elasticities (Red curve) and median elasticities from literature (Blue Dot)
- **Selection:** Supply elasticity: 0.11; Demand elasticity: -0.11 .

Identification of the VAR

Oil Market Interactions with Global Economy and Exclusion Restrictions

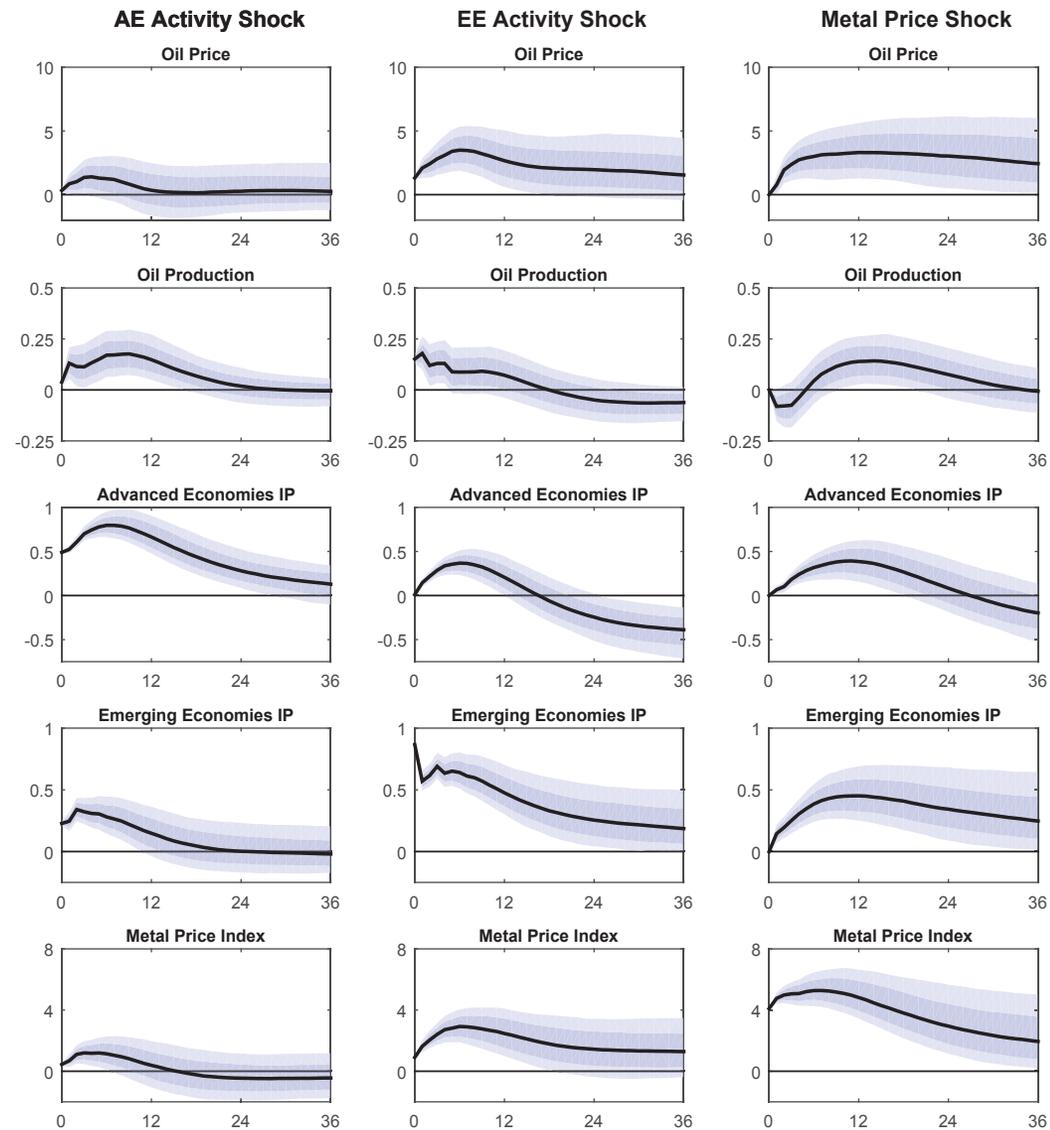
- Global Economy → Oil Market:
 - Global demand shifts oil demand curve;
 - Global demand cannot shift oil supply curve;
 - **NOTE:** Oil production moves in response to global demand shocks because supply curve is price-elastic.
- Oil Market → Global Economy:
 - IPs respond directly to changes in oil production;
 - Metal prices respond to changes in both oil prices and oil production.

Impulse Responses to Oil Market Shocks



- **Negative supply shock:** Raises prices; Depresses IP advanced; Raises IP emerging
- **Positive demand shock:** Raises prices and production; Small effects on IPs

Impulse Responses to Global Activity Shocks



- **Positive global activity shocks:** Raise oil prices and production

Forecast Error Variance Decomposition

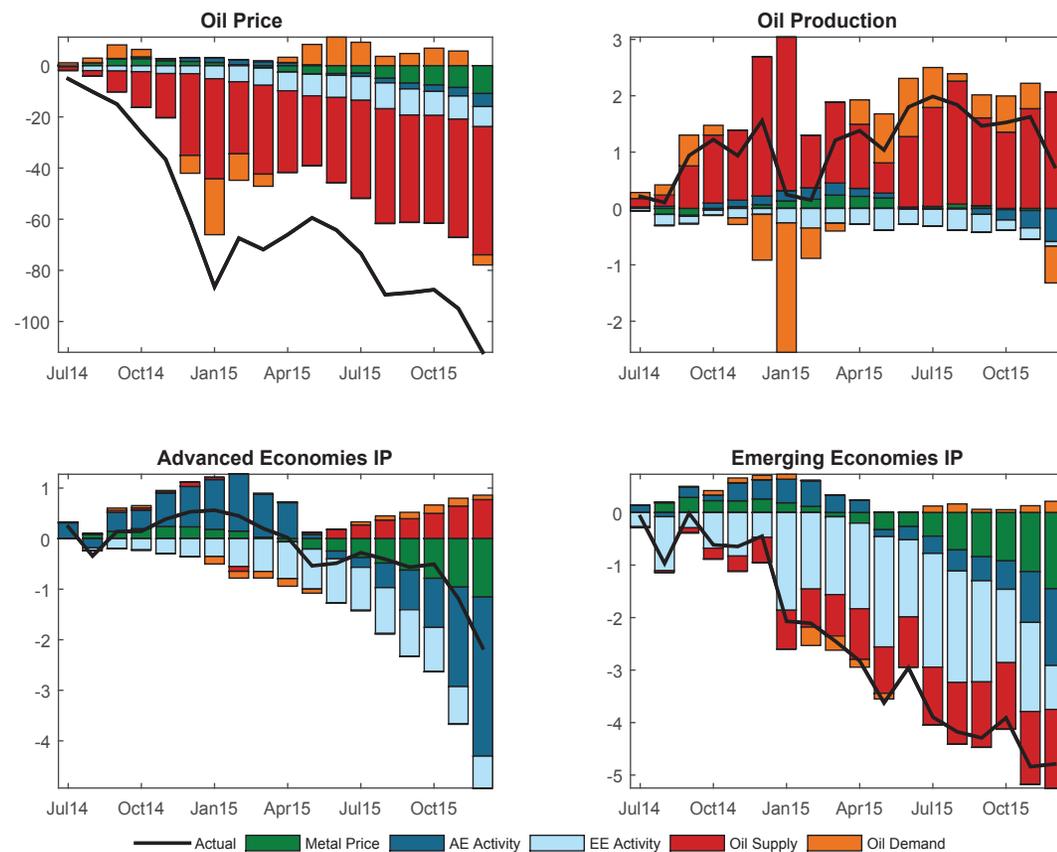
24-Month Ahead

| Shocks | Oil Supply | Oil Demand | AE Activity | EE Activity | Metal |
|-------------|------------|------------|-------------|-------------|-------|
| Oil Prices | 47.6 | 14.3 | 2.2 | 13.4 | 16.8 |
| AE Activity | 5.5 | 1.8 | 63.8 | 10.7 | 14.6 |
| EE Activity | 5.8 | 1.7 | 8.4 | 52.0 | 29.1 |

- **Oil price fluctuations:**
 - **Supply shocks** account for **about 50 percent**
 - **Demand shocks** for **about 15 percent**
 - **IP emerging** and **metals prices** account for **about 30 percent**
 - Little role for IP advanced

Historical Decomposition

2014-2015 Oil Price Slump



- Most of decline attributed to **supply shocks**
- Early 2015: Negative oil-specific demand shocks
- 2015: Negative shocks to (1) IP emerging; (2) expectations of global activity captured by metals prices

VAR model with Oil inventories

- Extend VAR model of the oil market to include oil inventories
Similar to Baumeister and Hamilton (2015).
- Inventories absorb differences between oil production and oil consumption
- Set of VAR-admissible supply and demand elasticities very close to baseline model.
- Selected elasticities nearly identical to baseline model
- **Positive inventory-demand shock:** Higher inventories and modest increase in prices
- Historical decomposition of oil price fluctuations:
 - Small contribution from inventories-demand shocks
 - Including inventories not altering contribution of remaining shocks
 - Supply shocks remain key drivers of oil price fluctuations

Concluding Remarks

- Identify VAR of oil market and global economy with *plausible joint restrictions* on oil supply and oil demand elasticities
- Supply shocks:
 - Key drivers of oil prices
 - Have economically modest effects on global activity
- 2014–2015 price slump:
 - Supply shocks account for substantial share
 - Global activity shocks started playing role in early 2015
- Also in the paper:
 - With lower supply elasticity → large demand elasticity:
 - Oil-specific demand shocks key drivers of oil prices
 - Oil supply shocks associated with large oil price multiplier on advanced economies activity
 - With only one indicator of global activity: Small contribution of global demand to oil prices