Oil Price Elasticities and Oil Price Fluctuations

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**DISCLAIMER:** The views expressed are solely the responsibility of the authors and should not be interpreted as reflecting the views of the Board of Governors of the Federal Reserve System or of anyone else associated with the Federal Reserve System.
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 classical questions in the literature:
- What drives oil price movements?
- What are the macroeconomic effects of oil price shocks?

This paper provides new evidence on the causes and consequences of oil price fluctuations for the 1985–2015 period.
Introduction
Methodology and Preview of Results

- Structural VAR to analyze sources and macroeconomic effects of oil price movements

- Novel identification and data to disentangle supply and demand shocks:
  - Joint restrictions on oil supply and demand elasticities;
  - Multiple indicators of global demand for oil.

- Main findings:
  - Supply shocks main driver of oil prices;
  - Supply shocks boost activity in advanced economies while depress activity in emerging economies;
  - Selection of 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;
  - Ability to explain oil prices.

- Construct IP indexes for 19 advanced and 33 emerging economies (90% World GDP):
  - Reliable and widely available business cycle indicator;
  - Oil important input in industrial sector;
  - Advanced economies net oil importers;
  - Emerging economies use more oil and oil independent.
Measuring Global Demand for Oil
Leading Indicator: Metals 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

- Results from forecasting regressions:
  - Metal prices help predict global activity and oil prices.
The VAR Model

- VAR model of the oil market and the global economy with 5 variables (Jan 1985 - Dec 2015):
  - Log of IP for advanced economies;
  - Log of IP for emerging economies;
  - Log of IMF metals price index;
  - Log of Brent price of crude oil (deflated by U.S. CPI);
  - Log of global supply of crude oil.
Identification of the SVAR

The Oil Market

- 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 \( \eta_S \) and \( \eta_D \) both small:
  - Estimates from meta-analysis: \( \eta_S = 0.13; \eta_D = -0.13; \)
  - \( \eta_S \) 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.
IDENTIFICATION

VAR-Implied Demand and Supply Elasticities

Oil Supply Elasticity ($\eta_S$)
-0.05 0 0.05 0.1 0.15 0.2

Oil Demand Elasticity ($\eta_D$)
-0.5
-0.4
-0.3
-0.2
-0.1
0

Constraint
Estimates from Literature
Selected Restrictions

Diagram:
- Oil Demand Elasticity ($\eta_D$) on the y-axis.
- Oil Supply Elasticity ($\eta_S$) on the x-axis.
- Constraints and selected restrictions indicated.
- Points from literature estimates.
Macroeconomy $\rightarrow$ oil market:

- Global demand can shift the oil demand curve;
- Global demand cannot shift the oil supply curve;
- **NOTE:** Oil production moves in response to global demand shocks because supply curve is elastic.

Oil market $\rightarrow$ macroeconomy:

- IPs respond directly to changes in oil production;
- Metals prices respond to changes in both oil prices and oil production.
**IMPULSE RESPONSES**

**Oil Price Shocks**

**Oil Supply Shock**

- **Oil Price**: Graph showing the response of oil price over time, with peaks and troughs indicating changes in price due to supply shocks.
- **Oil Production**: Graph showing the response of oil production, with an initial increase followed by a decrease due to supply constraints.
- **Advanced Economies IP**: Graph showing the impact on advanced economies, with a delayed response in terms of industrial production.
- **Emerging Economies IP**: Graph showing the impact on emerging economies, with a more immediate and significant response in terms of industrial production.

**Oil Demand Shock**

- **Oil Price**: Graph showing the response of oil price over time, with peaks and troughs indicating changes in price due to demand shocks.
- **Oil Production**: Graph showing the response of oil production, with an initial decrease followed by an increase due to increased demand.
- **Advanced Economies IP**: Graph showing the impact on advanced economies, with a delayed response in terms of industrial production.
- **Emerging Economies IP**: Graph showing the impact on emerging economies, with a more immediate and significant response in terms of industrial production.

**IRFs Global Shocks**
## Forecast Error Variance Decomposition

### 24-Month Ahead

<table>
<thead>
<tr>
<th>Shock</th>
<th>Oil Supply</th>
<th>Oil Demand</th>
<th>AE Activity</th>
<th>EE Activity</th>
<th>Metal</th>
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<td>14.3</td>
<td>2.2</td>
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<td>[9.5; 22.3]</td>
<td>[0.8; 5.3]</td>
<td>[6.2; 23.0]</td>
<td>[8.3; 28.3]</td>
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<tr>
<td>AE Activity</td>
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<td>1.8</td>
<td>63.8</td>
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<td>[0.7; 4.5]</td>
<td>[51.7; 74.3]</td>
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<tr>
<td>EE Activity</td>
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<td>[16.6; 41.1]</td>
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</tr>
</tbody>
</table>
HISTORICAL DECOMPOSITION
2014–2015 Oil Price Slump

Oil Price

Oil Production

Advanced Economies IP

Emerging Economies IP

Legend:
- Actual
- Metal Price
- AE Activity
- EE Activity
- Oil Supply
- Oil Demand
CONCLUDING REMARKS

- Identify SVAR of oil market and the global economy with plausible joint restrictions on oil supply and oil demand elasticities.

- Show that oil supply shocks are key drivers of oil prices and have an economically modest effect on global real activity.

- Also in the paper:
  - With low supply elasticity $\rightarrow$ 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.
IMPULSE RESPONSES

Oil Price Shocks