OPEC, Saudi Arabia, and the Shale Revolution:
Insights from Equilibrium Modelling and Oil Politics

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Paris, 26th April, 2018
• 2014 – 2016: **Oil price crash**, following US shale growth and an
  OPEC decision not to cut production
• Previous literature: No consensus on OPEC’s intention
  • *OPEC defeat, OPEC attack, or OPEC experiment?*
• **Bathtub model** to examine if static competition can explain
  price developments consistently over time
• **Qualitative discussion** about oil politics of OPEC and Saudi
  Arabia in particular
• Conclusions:
  • OPEC decision most likely an **attempt to drive out shale** and to **test for
    shale elasticity**
  • Shale oil might have altered competition permanently, but **OPEC is still
    an important player**
Content

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Background:

Developments and scientific discourse
Background

WTI quarterly price. Data: Thomson Reuters

Crude oil production capacities
Data: IEA, own calculations

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Price drop
Nov 2014
Vienna talks: No OPEC cuts

Price collapse
Dec 2015:
Vienna talks: Still no cuts

Jun 2016
OPEC deal talks fail

Feb 2016
Russia signals interest in cuts

Nov. 2016
Production cut agreed (incl. Russia, Iran)
No literature consensus

- Shale oil revolution (e.g. Aguilera and Radetzki, 2015)
- Financial speculation (e.g. Fantazzini, 2016, Tokic, 2015)
- Dampened demand (e.g. Baumeister and Kilian, 2016)
- New economics of oil (Dale, 2016)
- OPEC Behaviour
- Geopolitical stabilisation (e.g. Baffes et al., 2015)

OPEC floods the market to drive out shale

OPEC lost its position as the swing supplier to shale

Uncertainty

- Behar and Ritz (2017)
- Coy (2015)
- Gause (2015)
- Mănescu and Nuño (2015)

- Fattouh et al. (2016)
- Huppmann and Livingston (2015)

- Baffes et al. (2015)
- Baumeister and Kilian (2016)
- Dale (2016)
- Kaletsy (2015)
- The Economist (2015)
OPEC’s own interpretation

“[Ali al-Naimi’s] biggest move was the latest one of defending Saudi market share, and abandoning the OPEC swing role.”

Mohammad al-Sabban, June 2015

[...]

It is not in the interest of OPEC producers to cut their production.

[...] Whether [the price] goes down to $20/B, $40/B, $50/B, $60/B, it is irrelevant. [...] But if it goes down, others will be harmed greatly before we feel any pain.

Ali al-Naimi, November 2014

Does history back this decision?

OPEC states:
We will flood the market and defend our market share!
Is OPEC a cartel?

- No Cartel: e.g. Kisswani (2016), Plaut (1981)
- Somewhat of a Cartel: e.g. Huppmann & Holz (2012), Almoguera et al. (2011)
- Something weird: e.g. Kisswani (2014), Hochman and Zilberman (2015)

And even worse: How to model that?

Fattouh and Mahadeva (2013): Changing OPEC objectives and behaviour over time make it impossible to have a single model explaining all OPEC history.
A (not-so) simple model of the crude oil market
Model description

### Perfect Competition
**Lower-end benchmark**

### Cournot
**Equal market power**

### Stackelberg:
- KSA / United OPEC vs
- Cournot / Fringe
  **Asymmetric market power**

#### Bathtub market
- Homogeneous crude
- **Pool model**: Unified, global demand function
- **Relaxation**: quality adjustment

#### Present profit maximisation
- No dynamic strategic behaviour
- Full information and certainty

#### Golombek production costs

#### Linear demand
- From actual demand and fixed elasticity

An extension of Huppmann (2013)

\[
\max_{q_{it}} \left\{ p_t(q_{it}) - C_t(q_{it}) \mid q_{-it}^S \right\} \forall i, t
\]

\( \text{t: 2011 Q4 – 2015 Q4, quarterly} \)
## Data & Implementation

<table>
<thead>
<tr>
<th>Type</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply</td>
<td>IEA (29 suppliers with 94.4% of global supply)</td>
</tr>
<tr>
<td>Capacities</td>
<td>OPEC: IEA, non-OPEC: 97%-of-output rule and IEA (e.g. Behar &amp; Ritz, 2017)</td>
</tr>
<tr>
<td>Production costs</td>
<td>DIW data set (e.g. Langer et al, 2016)</td>
</tr>
<tr>
<td>Oil quality</td>
<td>Calculations based on US Dept. of Energy, EIA, Oil &amp; Gas Journal</td>
</tr>
<tr>
<td>adjustment</td>
<td></td>
</tr>
<tr>
<td>Demand</td>
<td>Survey-based: Javan &amp; Zahran (2015), Caldara et al. (2016)</td>
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<tr>
<td>elasticity</td>
<td></td>
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### Setup
- Cournot, Perfect Comp.
- Stackelberg

### Formulation
- MCP
- MPEC $\rightarrow$ MINLP

### Solver
- PATH
- Bonmin, Couenne

Share in global crude production capacities

Gini coefficient: 0.505

Data: IEA and own calculations
Results: Price trajectories

Actual and computed price trajectories

Goodness of fit

<table>
<thead>
<tr>
<th>ARME in %</th>
<th>KSA-FR</th>
<th>PC</th>
<th>KSA-CO</th>
<th>Cournot</th>
<th>UNI-CO</th>
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<tbody>
<tr>
<td>Overall</td>
<td>23</td>
<td>27</td>
<td>35</td>
<td>52</td>
<td>120</td>
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<tr>
<td>First period</td>
<td>25</td>
<td>31</td>
<td>24</td>
<td>43</td>
<td>121</td>
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<tr>
<td>Second period</td>
<td>18</td>
<td>18</td>
<td>63</td>
<td>75</td>
<td>119</td>
</tr>
</tbody>
</table>
Results: United OPEC

Computed profits (left) and production quantities (right) in the United OPEC setup in Q1 2015 by Saudi Arabia (KSA) and other OPEC members.
Results: Sensitivity analysis

Robustness of the perfect competition results to cost variations (overall cost reductions in %)
Qualitative discussion:
Oil Politics
Saudi calculus: Revenues or market-shares?

- **Trade-off** between revenue maximisation and market-shares
- Prolonged low oil prices can result in economic and political havoc
- Geopolitical impact ambiguous, Saudi Arabia advances in refining, Vision 2030
- A toughened oil market endangered by **peak-demand** (climate policies, alternative tech.)
  - Green paradox?
- Similarities to the 1980s?
- Saudi-Arabia’s priority in deal negotiations:
  - No moral hazard!
  - No self-harm
- Influence of domestic politics?

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Shale Performance under Pressure

- Shale economics: Different cooperative, financial, and cost structure
- Severe overvaluation of shale breakeven before the drop
- Potential misunderstanding of the breakeven concept itself (Kleinberg et al., 2016)
- Significant decrease in production, although far below OPEC hopes (OPEC, 2016)

Month-to-month and quarter-to-quarter changes in US rigs (left) and quarter-to-quarter and year-to-year changes in US daily crude oil production (right). Data: EIA
Summary & Conclusion
Conclusion

- Prices **before the drop** are consistent with **static short-term profit maximisation**.
- Prices **after the drop** can hardly result from such a behaviour but rather from **dynamic calculus or information-revealing behaviour**.
- Shale oil might have altered competition permanently, but **OPEC stays an important player** in the market.
- Oil can potentially continue to move in a price corridor, defined by mutual incentives and technology
- Modelling OPEC is anything but trivial.
Thank you for your attention.
References

- Dale, S., 2016. New Economics of Oil. Oil and Gas, Natural Resources, and Energy Journal 1, 3.
References (cont’d)

- OPEC, 2016. World Oil Outlook.