Inscrutable OPEC?
A Production Test of the Cartel Hypothesis

James L. Smith
Department of Finance
Southern Methodist University
Dallas, TX  75275
jsmith@mail.cox.smu.edu
Is OPEC a Cartel?

Obviously...
1. Conspicuous, regularly scheduled meetings to discuss pricing goals.
2. Formal quota system in place since 1982.
3. Persistently large excess/underutilized capacity.

But...
1. What about “cheating”?
2. Political & economic factors undermine cooperation.
3. Who is in the “core,” and who is not, and what is it?
4. “Mere interdependence” $\neq$ collusion.
5. Show me the money...  
   \textit{STATISTICAL EVIDENCE}???
The “Scientific” Method: How We Learn

**Question:** Where’s Waldo??

$H_0$: Waldo is in Houston

$H_a$: Waldo is in Dallas

**Evidence:**

???
Question: Where’s Waldo??

$H_o$: Waldo is in Houston
$H_a$: Waldo is in Dallas

Evidence:
1. Waldo arrived in this city by car, via IH-45.
Question: Where’s Waldo??

H<sub>0</sub>: Waldo is in Houston
H<sub>a</sub>: Waldo is in Dallas

Evidence:
1. Waldo arrived in this city by car, via IH-45.
2. He could have flown in instead using Southwest Airlines, landing at the convenient but relatively small in-town airfield.
Question: Where’s Waldo??

$H_0$: Waldo is in Houston  
$H_a$: Waldo is in Dallas

**Evidence:**

1. Waldo arrived in this city by car, via IH-45.
2. He could have flown in instead using Southwest Airlines, landing at the convenient but relatively small in-town airfield.
3. Tomorrow, Waldo will visit a prominent university (sometimes known for football futility) located in a good part of town.
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1. Waldo arrived in this city by car, via IH-45.
2. He could have flown in instead using Southwest Airlines, landing at the convenient but relatively small in-town airfield.
3. Tomorrow, Waldo will visit a prominent university (sometimes known for football futility) located in a good part of town.
4. Yesterday, Waldo met friends at the Petroleum Club, same place the local USAEE chapter used to hold monthly meetings, and then spent the afternoon shopping at the Galleria.
Question: Where’s Waldo??

H₀: Waldo is in Houston
Hₐ: Waldo is in Dallas

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2. He could have flown in instead using Southwest Airlines, landing at the convenient but relatively small in-town airfield.

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4. Yesterday, Waldo met friends at the Petroleum Club, same place the local USAEE chapter used to hold monthly meetings, and then spent the afternoon shopping at the Galleria.

5. Waldo hoped to take the controversial new commuter rail line to the airport, but it doesn’t go there.
The standard practice to date has been to reach onto the shelf of economic models, to select one, to validate its choice by pointing to selected events *not inconsistent* with the model’s predictions, and then to proceed with some normative exercise.

James Griffin  
*American Economic Review*, 1985
Indistinguishable ???

COMPETITION

COLLUSION
Indistinguishable ???

... the fog of data
Perfect Competition

$p = mr$

$mc_1$

$mc_2$

$q_1$

$q_2$

$\text{Individual Output}$
Perfect Competition

- Shocks Don’t Propagate Reactions -

$p = mr$

$mc_1$

$mc_2$

$q_1$

$q_2$

$q_2$

Individual Output
Cournot (Nash) Equilibrium

RF₂: \( mr₂(q₂|q₁) = mc₂(q₂) \)

\[ q₁ \quad q₂ \]

\[ RF₁ \quad RF₂ \]
Cournot (Nash) Equilibrium

- Shocks Propagate Moderate Reactions -

RF₂: \( mr₂(q₂|q₁) = mc₂(q₂) \)
Perfect Cartel (Multi-Plant Monopoly)

$\text{Individual Output}\$

$\text{Perfect Cartel (Multi-Plant Monopoly)}$

$\text{marginal revenue}$

$\text{mc}_1$  

$\text{mc}_1 + \text{mc}_2$

$\text{mr} = \text{mc}$

$q_1$  

$q_1 + q_2$
Perfect Cartel (Multi-Plant Monopoly)

- Shocks Propagate Strong Reactions -

$\begin{align*}
q_1 + q_2 &= mc_1 \\
q_1 + q_2 &= mc_1 + mc_2 \\
mr &= mc
\end{align*}$

$\begin{align*}
q_1 \\
q_1 + q_2 \\
q_1 + q_2
\end{align*}$

Individual Output
Testable Hypotheses from Oligopoly Theory:

Correlations Among Individual Production Changes

\[ \rho_{\text{cartel}} < \rho_{\text{bertrand}} < \rho_{\text{stackelberg}} < \rho_{\text{cournot}} < \rho_{\text{perfcomp}} = 0 \]

and

\[ \rho_{\text{cartel}} < \rho_{\text{bureaucratic syndicate}} \]
Table 1:
Correlations Between Monthly Production Changes

<table>
<thead>
<tr>
<th>... vs. Rest of OPEC</th>
<th>correlation</th>
<th>H1: $\rho &gt; 2.4%$ test statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algeria</td>
<td>12.3%</td>
<td>1.85 *</td>
</tr>
<tr>
<td>Indonesia</td>
<td>20.4%</td>
<td>3.40 **</td>
</tr>
<tr>
<td>Iran</td>
<td>18.3%</td>
<td>2.99 **</td>
</tr>
<tr>
<td>Iraq</td>
<td>11.4%</td>
<td>1.68 *</td>
</tr>
<tr>
<td>Kuwait</td>
<td>44.4%</td>
<td>8.41 **</td>
</tr>
<tr>
<td>Libya</td>
<td>27.5%</td>
<td>4.79 **</td>
</tr>
<tr>
<td>Nigeria</td>
<td>21.8%</td>
<td>3.67 **</td>
</tr>
<tr>
<td>Qatar</td>
<td>10.9%</td>
<td>1.59</td>
</tr>
<tr>
<td>UAE</td>
<td>38.4%</td>
<td>7.07 **</td>
</tr>
<tr>
<td>Venezuela</td>
<td>18.5%</td>
<td>3.03 **</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>27.7%</td>
<td>4.83 **</td>
</tr>
<tr>
<td>OPEC average</td>
<td>22.9%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>... vs. Non-OPEC</th>
<th>correlation</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>-5.3%</td>
<td>-1.42</td>
</tr>
<tr>
<td>China</td>
<td>1.8%</td>
<td>-0.11</td>
</tr>
<tr>
<td>Egypt</td>
<td>-1.0%</td>
<td>-0.63</td>
</tr>
<tr>
<td>Mexico</td>
<td>-8.8%</td>
<td>-2.08</td>
</tr>
<tr>
<td>Norway</td>
<td>17.3%</td>
<td>2.80 **</td>
</tr>
<tr>
<td>Russia</td>
<td>-3.6%</td>
<td>-1.11</td>
</tr>
<tr>
<td>UK</td>
<td>13.0%</td>
<td>1.98 *</td>
</tr>
<tr>
<td>US</td>
<td>5.6%</td>
<td>0.60</td>
</tr>
<tr>
<td>Non-OPEC avg.</td>
<td>2.4%</td>
<td></td>
</tr>
</tbody>
</table>

** significant at 1% level.
* significant at 5% level.

Note: "Rest of OPEC" consists of all OPEC production, less the production of any OPEC country to which it is compared. "Non-OPEC" consists of worldwide production net of OPEC and the production of any Non-OPEC country to which it is compared.
Conclusions

1. Most traditional hypotheses are clearly rejected by production tests ... competitive, Cournot, Stackelberg, multi-plant monopoly, etc.

2. OPEC is much more than a non-cooperative oligopoly...  
   ... but less than a frictionless cartel.

3. OPEC is weighed down by transactions costs (consensus building)  
   ... therefore partially impaired in pursuit of the “common good.”


5. Mixed (weak) evidence that Saudis have acted as “swing producer.”
Market Value of Capacity Withheld by OPEC

(Source: EIA and author's calculations)
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(Source: EIA and author's calculations)