ROTARY-RIG PARITY:
THE DRILLING-AUGMENTED OIL/GAS PRICE RELATIONSHIP

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Motivation: A Regime Change
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- Oil Directed Rigs
- Gas Directed Rigs
Increasing Productivity (Oil)
Increasing Productivity (Gas)
Market Links

■ Demand
  – “Burner-tip Parity”

■ Supply
  – Associated commodities
  – Rig competition
  – “Rotary-rig Parity”

■ Previous Work
  – Established supply links at basin level

■ This paper
  – Aggregate up to relationships at US market level
Model

■ Rotary-Rig Parity (RRP)
  - Marginal profit associated with drilling oil wells should equal marginal profit associated with drilling gas wells in the long run
  - RRP holds if scarcity rents of gas and oil are similar
    ■ E.g., both are relatively abundant

\[
mp_o = \frac{P_o}{\alpha_o + r} + \frac{\psi_g P_g}{\alpha_g + r} - C_o'(q_o + q_g, q_o, \psi_g)
\]

\[
mp_g = \frac{P_g}{\alpha_g + r} + \frac{\psi_o P_o}{\alpha_o + r} - C_g'(q_o + q_g, q_g, \psi_o)
\]
\[
\frac{(1 - \psi_g)P_g}{\alpha_g + r} = \frac{(1 - \psi_o)P_o}{\alpha_0 + r} + (b_g + b_{\psi_o})q_g + (b_o + b_{\psi_g})q_o
\]

\[
P_g = \left[ \frac{\alpha_g + r}{1 - \psi_g} \right] \left[ \frac{(1 - \psi_o)P_o}{\alpha_o + r} + (b_g + b_{\psi_o})q_g + (b_o + b_{\psi_g})q_o \right]
\]

- Compare models (cointegrating vectors) with and without rigs
**Empirical Results**

<table>
<thead>
<tr>
<th>Model</th>
<th>ln(Gas Price)</th>
<th>ln(Oil Price)</th>
<th>ln(Gas Rigs)</th>
<th>ln(Oil Rigs)</th>
<th>AIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prices (01/1994 to 08/2010)</td>
<td>1</td>
<td>0.758***</td>
<td>-----</td>
<td>-----</td>
<td>-3.46</td>
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<td></td>
<td></td>
<td>(0.192)</td>
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<tr>
<td>Prices &amp; Rigs I (01/1994 to 08/2010)</td>
<td>1</td>
<td>0</td>
<td>1.26***</td>
<td>0.090</td>
<td>-10.26</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>(0.073)</td>
<td>(0.089)</td>
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<tr>
<td>Prices &amp; Rigs II (01/1994 to 08/2010)</td>
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<td>1</td>
<td>1.067***</td>
<td>0.318***</td>
<td>-10.26</td>
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<tr>
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<td></td>
<td></td>
<td>(0.092)</td>
<td>(0.112)</td>
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<tr>
<td>Prices (01/1994 to 12/2018)</td>
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<td>0.259</td>
<td>-----</td>
<td>-----</td>
<td>-3.68</td>
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<tr>
<td></td>
<td></td>
<td>(0.274)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Prices &amp; Rigs (01/1994 to 12/2018)</td>
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<td>1.01***</td>
<td>0.172***</td>
<td>0.441***</td>
<td>-10.47</td>
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<td></td>
<td>(0.088)</td>
<td>(0.065)</td>
<td>(0.082)</td>
<td></td>
</tr>
</tbody>
</table>

- Deviations from the long-run relationships lead gas prices, gas rigs, and oil rigs to adjust in the short-run.
Empirical Results

Coefficient on \( \ln(\text{Oil Price}) \)
Conclusion

- Movement from relative scarcity to relative abundance of gas and oil has changed the oil-gas price relationship.
- Relative abundance has led producers to allocate drilling such that marginal profits across well types are similar - RRP.
- RRP leads to a long-run relationship of gas prices, oil prices, gas rigs and oil rigs.
- The parameters of the model are determined by commodity-specific costs, associated-commodity flows, and decline rates.
- Watch for changes over time.