A Less Volatile Crude Oil Price: Supply Rotation Control

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PURPOSE

- Smooth the crude oil price

reduce the volatility cost
APPROACH

- Find Main Source of Volatility
- Principle to Solve Problem
  (Incentive Compatibility)
- Method: Rotation Control
- Detail: Market Situation/Demand Elasticity
- Technique: Bootstrapping Method
WHY PRICE VOLATILE

- Fundamental (Demand/Supply) (OPEC’s Influence)
- Financial Market (Technical Analysis/Information Noise)
- WAR
CRUDE OIL PRICE FORMULAS

- $P_x = \text{Benchmark Price} + \text{Premium}$
- Benchmark Price
  (WTI/BRENT/DUBAI&OMAN)
- Spot price $\sim$ Futures price (-1)
- Futures Prices is Selected Due to Transparency
- Transparency in Futures Market Can’t Guarantee the (Physical Market Clear )
OIL MARKET TRANSPARANCY

World market → Quota N.E. Production → Arbitrage

OPEC market

Financial market
WHO SHOULD RESPONSIBLE FOR

- OPEC OR FINANCIAL MARKET PLAYERS?

No Market Imbalance
  (D/S Gaps or Info Bias)

No Arbitration trade

- Better control for OPEC would help for less volatility
PERSUASIVE PRODUCTION (Incentive Compatibility)

Privilege Assignment

Responsible for price if I’m the only decision maker
(Each time only 1 member/group in OPEC has privilege)

Supply Rotation Control
Figure 1 The determination of market price.
HOW IT WORKS

- More Stable Oil Supply Will Flow Into the Market
- More Reliable Information Is Perceived
- Fewer Arbitration trade
- More Stable Oil Price
Simulation Techniques

- Bootstrapping Method
  (Market Data Distribution/Simulation)
- Real Market Situation (Inelastic demand)
- Supply Rotation Control
Figure 2 Historical WTI Price Trend ($p, \Delta p$)
Decide the Data Set of Calculating $\Delta p$ from 1986/1/2 to 2003/7/22

Equation (1)&(2)

Market Price Determination

$\bar{p}_j (or \underline{p}_j) = p^* + \Delta p_i$

Equation (3)

Demand Price Elasticity

$\varepsilon_d = -0.06$

Original Equilibrium

$p^* = 24.138 \quad q^* = 76.9$

Without Control

With Control

Random choosing 1000 $\Delta p_i$ from Data Set ⇒ Possible Oil Price Path

$p_i = p_{i-1} + \Delta p_i$

Random choosing 1000 $\Delta p_i$ from Data Set

 Boom Period

3 Scenarios

Each Has $\bar{p}_j$ & $\underline{p}_j$

$p_i = p_{i-1} + \Delta p_i$

$p_j \leq p_i \leq \bar{p}_j$

(j = 1, 2, 3)

Random choosing 1000 $\Delta p_i$ from Data Set

 Collapse Period

3 Scenarios

Each Has $\bar{p}_j$ & $\underline{p}_j$

$p_i = p_{i-1} + \Delta p_i$

$p_j \leq p_i \leq \bar{p}_j$

(j = 1, 2, 3)

Figure 3 Flow Chart of Simulation Process
Equation (1)

\[ \eta_d = \frac{\Delta Q}{\Delta P} = \frac{p^*}{Q^*} \cdot \frac{\Delta Q}{\Delta P} \]

where \( \eta_d \) : price elasticity of demand,
\( \Delta Q \) : change of supply quantity,
\( \Delta P \) : change of price,
\( Q^* \) : equilibrium quantity,
\( p^* \) : equilibrium price.

Random choosing 1000 \( \Delta p_i \) from Data Set \( \Rightarrow \) Possible Oil Price Path \( p_i = p_{i-1} + \Delta p_i \)

Figure 3 Flow Chart of Simulation Process
Equation (2)

\[ \Delta P = \eta_d \cdot \frac{Q^*}{P^*} \cdot \Delta Q \]

where \( \eta_d \) : price elasticity of demand,
\( \Delta Q \) : change of supply quantity,
\( \Delta P \) : change of price,
\( Q^* \) : equilibrium quantity,
\( P^* \) : equilibrium price.

Random choosing 1000 \( \Delta p \) from Data Set \( \Rightarrow \) Possible Oil Price Path \( p_t = p_{t-1} + \Delta p \)

Figure 3 Flow Chart of Simulation Process
Figure 4a: Possible Crude Oil Price Path (without any control)

Figure 4b: Possible Crude Oil Price Path (without any control)

Figure 4c: Possible Crude Oil Price Path (without any control)
Table 2  Price boom in less production with control

<table>
<thead>
<tr>
<th>Scenario (mb/d)</th>
<th>Max Price</th>
<th>Min Price</th>
<th>Average Price</th>
<th>Standard error</th>
<th>Figure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constraint (Loss1 /0.779)</td>
<td>28.698</td>
<td>20.708</td>
<td>25.533</td>
<td>1.638</td>
<td>Figure 5a</td>
</tr>
<tr>
<td>Constraint1 (Loss2 /1.888)</td>
<td>33.923</td>
<td>20.088</td>
<td>25.497</td>
<td>3.015</td>
<td>Figure 5b</td>
</tr>
<tr>
<td>Constraint4 (Loss3 /3.138)</td>
<td>41.228</td>
<td>20.688</td>
<td>29.242</td>
<td>5.394</td>
<td>Figure 5c</td>
</tr>
</tbody>
</table>

Note: Loss : the Total Loss Production of oil from OPEC.
Loss1: Iraq excess capacity=0, Other Member loss 20%, Nigeria loss 40%, Venezuela loss 10%.
Loss2: Iraq excess capacity=0, Other Member loss 20%, Nigeria loss 50%, Venezuela loss 25%.
Loss3: Iraq excess capacity=0, Other Member loss 25%, Nigeria loss 90%, Venezuela loss 40%.
Figure 5 Possible Crude Oil Price Path in Boom Period (with control)
<table>
<thead>
<tr>
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<th>Min Price</th>
<th>Average Price</th>
<th>Standard error</th>
<th>Figure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constraint (EC1 /1.075)</td>
<td>27.528</td>
<td>17.998</td>
<td>23.722</td>
<td>1.688</td>
<td>Figure 6a</td>
</tr>
<tr>
<td>Constraint (EC2 /2.150)</td>
<td>25.948</td>
<td>10.503</td>
<td>19.466</td>
<td>4.533</td>
<td>Figure 6b</td>
</tr>
<tr>
<td>Constraint (EC3 /3.101)</td>
<td>25.518</td>
<td>7.898</td>
<td>15.066</td>
<td>3.809</td>
<td>Figure 6c</td>
</tr>
</tbody>
</table>

Note: EC : the Total Excess capacity from OPEC.
EC1: Iraq production capacity=2.5mb/d, and quota=2, total OPEC quota=25.401(2003/6/1 level),
Total OPEC excess capacity=5.376, but all used 20%, 1.075mb/d.
EC2: Iraq production capacity=2.5mb/d, and quota=2, total OPEC quota=25.401(2003/6/1 level),
Total OPEC excess capacity=5.376, but all used 40%, 2.150mb/d.
EC3: Iraq can’t take over, so he’s excess capacity=0, and total OPEC quota=25.401mb/d,
Total OPEC excess capacity=3.101mb/d, all used.
Figure 6  Possible Crude Oil Price Path, in collapse period with Control

Figure 6a

Figure 6b

Figure 6c

Figure 6  Possible Crude Oil Price Path, in collapse period with Control
Conclusion

- Price Around Fair Price
- Supply Rotation : Privilege Assignment
- Less Volatile Price is Expected
- Further Research

(capsity utilization in Bootstrapping simulation)
Rate of change on P