Impact of Crude Oil Volatility on Network Design

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MIT and ILOG
US Diesel and Crude Oil Prices over time

- United States Spot Price FOB Weighted by Estimated Import Volume (Cents per gallon)
- U.S. No 2 Diesel Retail Sales by All Sellers (Cents per Gallon)
Relationship between Crude Oil price and Diesel Fuel Price

Trend Line Model

Diesel Retail Price (Cents per Gallon) = 2.38515*Crude Oil Price ($/barrel) + 132.292
Implications on crude oil price to transportation rates

- Given the relationship in the previous slide, we see that a $10/barrel increase in crude oil will result in ~$0.24/gallon increase in diesel fuel.
- Standard fuel surcharge methodology is to increase surcharge $0.01/mile for every $0.06 increase in diesel fuel.
- We conclude that for every $10 increase per barrel of crude oil price, we have an additional $0.04/mile increase in transportation rates.
Case Study: Oil Prices and the Logistics Network

- Manufacturer of consumer packaged goods
- Manufacturing is possible in three locations:
  - Philadelphia- Highest production cost
  - Omaha-
    - Juarez, Mexico- Lowest production cost
- 60 potential DC locations
- 888 aggregated customers
- Inbound transportation uses commercial TL carriers
  - TL averages 40,000 lbs/shipment
- Outbound transportation uses a private fleet
  - Private fleet averages 20,000 lbs/shipment
Case Study - Objectives

- Determine the best number and location of distribution centers, as well assignment of customers to DC’s.
- Determine the best allocation of production to their manufacturing locations.
- Understand how the optimal network would change as oil prices fluctuate
  - Roughly 25% of the supply chain costs are in transportation
Network Visualization
As crude oil price increases, transportation costs become more important relative to production and facility fixed costs. We expect:

- Production moves nearer to demand.
  - Cheaper manufacturing in Mexico is offset by higher transportation costs.

- Additional DC’s are more attractive.
  - As outbound transportation becomes more expensive, it becomes increasingly important to minimize the distance of the final leg.
Impact on Warehouse Locations

Moving from $125/ barrel to $150/ barrel changes the optimal number of DC’s from 5 to 7. In particular, you can think of Las Vegas being replaced by Los Angeles, Albuquerque, and Portland.
Total Cost Comparison

<table>
<thead>
<tr>
<th>Cost Type</th>
<th>$75/ barrel</th>
<th>$100/ barrel</th>
<th>$125/ barrel</th>
<th>$150/ barrel</th>
<th>$175/ barrel</th>
<th>$200/ barrel</th>
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</thead>
<tbody>
<tr>
<td>Production Cost</td>
<td>51,352,370</td>
<td>53,978,928</td>
<td>54,034,995</td>
<td>54,032,003</td>
<td>54,071,680</td>
<td>54,149,335</td>
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<tr>
<td>Warehouse Fixed Costs</td>
<td>5,250,000</td>
<td>5,250,000</td>
<td>5,250,000</td>
<td>7,350,000</td>
<td>7,350,000</td>
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<tr>
<td>Warehouse to Customer Shipping Costs</td>
<td>12,138,280</td>
<td>12,951,623</td>
<td>13,796,249</td>
<td>12,205,702</td>
<td>12,913,436</td>
<td>13,698,938</td>
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<td>Plant to Warehouse Shipping Cost</td>
<td>10,179,282</td>
<td>8,083,064</td>
<td>8,502,896</td>
<td>9,287,443</td>
<td>9,730,287</td>
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<tr>
<td>TOTAL COST</td>
<td>82,913,987</td>
<td>84,257,670</td>
<td>85,578,194</td>
<td>86,869,203</td>
<td>88,059,459</td>
<td>89,247,365</td>
</tr>
</tbody>
</table>

3% increase in total cost as the price of a barrel increases from $100 to $150