Crude Oil Price Differentials and Pipeline Investment

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ITAM
Rapid growth in production since 2011 has reshaped geography of oil markets in the US

Source: EIA crude oil production
Total length of US crude oil pipelines increased by 37% between 2010 and 2016

Source: PHMSA Annual Hazardous Liquids data
Economic costs and benefits of major oil pipeline projects are ignored or misstated in media reports

This paper studies the economic effects of additions to pipeline capacity

- Additional pipelines displace shipment by more expensive alternatives (such as rail or trucks)
- Greater use of cheaper pipelines reduces the price dispersion across regions and the price discount to world prices
  - Refiners pay more for their inputs
  - Oil producers receive more for their output
- Possible environmental effects from displacement of rail—not considered here
Oil deliveries by pipeline to refineries increased by a third since 2009, matching increase in overall pipeline length

Source: EIA refinery receipts of crude oil by pipeline and rail
Monthly oil shipments by rail in 2016 less than half their level during 2015

Source: EIA movements of crude oil by rail
Large decline in the mean absolute deviation in US wellhead prices since its peak in 2011 and 2012

Source: EIA state-level crude oil first purchase prices
Similar decline in the mean discount of US wellhead prices from benchmark price (LLS)

Source: EIA state-level crude oil first purchase prices; Bloomberg
Stylized economic framework
Suppose we have an isolated region with oil production and inelastic oil demand from local refineries.
Without any trade ("autarky") the price of oil in this region will be very low.
The world price of oil is much higher... but the oil needs to be transported out of the region to a market hub.
There are low and high cost methods for transporting the oil, each with a limited capacity.
Local oil producers will receive price $P_1$, discounted from the world price to reflect the cost of transporting the last barrel.
Suppose there is an expansion in pipeline capacity out of the region, so that all exported oil can be carried by pipeline.
The price received by local oil producers increases from $P_1$ to $P_2$, reducing the discount from the world price.
Local oil producers will be better off as a result of the higher price (and slightly higher production quantity).
Local oil refineries are worse off because now they pay a higher price $P_2$ for their crude oil input.
Oil shippers with access to the original pipeline are also worse off, because they can no longer profit from buying oil at $P_1$. 
Overall welfare increases after the pipeline expansion, due to reduction in transportation costs and higher oil production.
Pipeline expansions in the Permian basin
Oil production in the Permian basin increased by 1.2 million barrels/day between 2010 and 2016.

Source: EIA Drilling Productivity Report
Only four pipelines out of Permian basin in 2010: Borger, Basin, Centurion, West Texas Gulf

Source: EIA geographical shape files
Rail loading terminals in Permian and Eagle Ford allowed shipment by rail to Gulf Coast refineries

Source: EIA geographical shape files
Six new pipelines were constructed (or converted) between 2012 and 2016, increasing access to Gulf Coast.

Source: EIA geographical shape files, Sunoco Logistics
Permian production exceeded refinery and pipeline capacity in 2012 and again in 2014.

Sources: EIA oil production; EIA refinery capacity utilization; RBN Energy and other news reports.
Periods with excess supply associated with large price differentials between Permian (WTI Midland) and Gulf Coast (LLS)

Sources: Excess supply calculation (previous slide); Bloomberg
Periods with excess supply associated with large price differentials between Permian (WTI Midland) and WTI Cushing

Sources: Excess supply calculation (previous slide); Bloomberg
Periods with excess supply associated with large price differentials between Permian (WTI Midland) and Gulf Coast (LLS)

Sources: Excess supply calculation (previous slide); Bloomberg
Empirically analyze the relationship between price differences and excess supply

- Allow WTI Cushing-LLS price differential to matter when marginal oil is sent to Cushing
- Include year fixed effects
- Change definition of refinery capacity
Societal benefits of $1.9 million/day compare to pipeline revenues of $0.3 million/day

Decompose the change in revenues and costs as a result of a hypothetical pipeline expansion

<table>
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<th>$ million/day</th>
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<tr>
<td>Higher oil producer revenue</td>
<td>$17.6</td>
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<tr>
<td>Higher oil refinery costs</td>
<td>$2.7</td>
</tr>
<tr>
<td>Lower oil shipper profits</td>
<td>$13.0</td>
</tr>
<tr>
<td>Lower transportation costs</td>
<td>$0.9</td>
</tr>
<tr>
<td>Higher oil production</td>
<td>$1.0</td>
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Higher input costs (mostly) reduced refinery profits rather than being passed on to gasoline consumers.
Refinery capacity utilization was already high and did not change as a result of the lower prices.

**Graphs:**
- **Inland Texas Refineries**
  - Scatter plot showing the relationship between the LLS – WTI Midland differential and refinery capacity utilization.
- **Individual Refineries**
  - Scatter plot for Big Spring and El Paso refineries, showing the same relationship.

**Source:** EIA, Texas Railroad Commission
Analysis for other oil producing regions
Colorado: Increase of about 250,000 barrels/day in oil production as well as greater oil pipeline capacity

Sources: EIA oil production; EIA refinery capacity utilization; RBN Energy and other news reports
Colorado–WTI Cushing price differentials are higher in periods with shortfall in pipeline capacity

Sources: Excess supply calculation (previous slide); Bloomberg; own calculations
Large increase in Bakken production not matched by additions to pipeline capacity

Sources: EIA Drilling Productivity Report; EIA refinery capacity utilization; ND Pipeline Authority and news reports
No obvious relationship between North Dakota–WTI Cushing price differential and excess supply measure

Sources: Excess supply calculation (previous slide); Bloomberg; own calculations
Note the pipeline expansions in North Dakota have been *infra-marginal*—implying no change in local price.
Other issues that complicate analysis of effect of pipeline infrastructure investment in other region

- Source of price data: market data vs. monthly average wellhead prices
- Capacity constraints in other parts of pipeline network
- Optimal flows through interconnected network
Conclusion
This paper has studied the economic effects of expansions to the crude oil pipeline network

- Length of crude oil pipeline network has increased by 37% between 2010 and 2016
- Additional pipelines have reduced the variance across regions in oil producer prices
  - Magnitude of reduction depends on whether new pipelines are inframarginal
- Most of the benefits for producers are a transfer from refiners and shippers
- Net welfare benefits are due to reducing cost of shipment and increasing oil production
  - These exceed revenue for pipeline owners