



## RESEARCH SUMMARY

# Crude by Rail, Option Value, and Pipeline Investment

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### KEY TAKEAWAYS

1. The use of rail instead of pipelines to transport crude oil has ebbed and flowed over time. While some believe this is because rail is a temporary option to be used as pipelines are being permitted and built, the study explores an alternative view: Crude-by-rail's inherent flexibility generates value and, in spite of rail's high price tag, reduces the incentive to invest in pipelines.
2. The authors build a model that evaluates how much larger the recently-constructed Dakota Access Pipeline would have been had crude-by-rail been more costly and less flexible.
3. The study finds that if rail were to be more expensive, more shippers would commit to pipeline contracts and pipelines would increase capacity.
4. Further, if rail were to be less flexible such that it was not able to reach multiple destinations, more shippers would commit to pipeline contracts and pipelines would increase capacity.
5. Policies that increase the cost of rail transport—such as regulations that target environmental and safety concerns—could lead to a long-run shift away from railroad transportation and toward pipeline investment.

## Introduction

From 2010 until the end of 2014, shipping crude oil by railroad in the United States grew from essentially nothing to more than 750,000 barrels per day (bpd). At its peak, crude oil shippers moved more than 10 percent of total U.S. domestic production by rail. This unprecedented boom in crude-by-rail is likely due in no small part to the remarkably fast ramp-up of oil production at North Dakota's Bakken shale play, one of the largest oil developments in the United States, as well as other production sites in the upper Midwest. The sudden spike in homegrown production in that part of the country left the dominant form of shipping oil—pipelines—unprepared. Pipeline operators didn't have the capacity to handle the influx of crude oil, and they didn't have the lines to all of the regions of the country that demanded it. So, shippers turned to rail.

Though rail is a more expensive alternative to pipelines, it has several advantages. Pipeline operators require shippers to sign a long-term contract in order to collect the upfront investment needed to build the pipeline. These contracts make it so that even when prices from oil in the Gulf are cheaper than prices from North Dakota's Bakken shale, shippers still have to pay the pipeline for the capacity they committed to. Rail does not require these long-term commitments, so that rail shippers can increase or decrease the volume in response to changes in prices. Moreover, rail allows oil to be shipped to or from many locations along the extensive existing tracks between the upper Midwest and nearly every major refining center in the country—not just one set line. So, for instance, coastal refiners can use oil from the Bakken shale only when it is cheaper than more local oil, and producers at the Bakken can ship output to whatever location has the highest demand. This flexibility allows shippers to decide when, where, and how much oil to ship based on market price signals.

However, rail also comes with possible disadvantages that could impact its cost and ease of use in the future. One such disadvantage is associated environmental damages. One study found air pollution associated with transporting crude oil by rail from the Bakken to the East Coast generated damages of \$2.73 per barrel, on average, owing primarily to emissions from freight locomotives. Given the amount of attention pipelines have received from environmental protestors, surprisingly the damage from rail pollution is nearly twice the pollution damage caused by pipeline transportation—and, even larger than estimated damages from spills and accidents associated with pipelines.

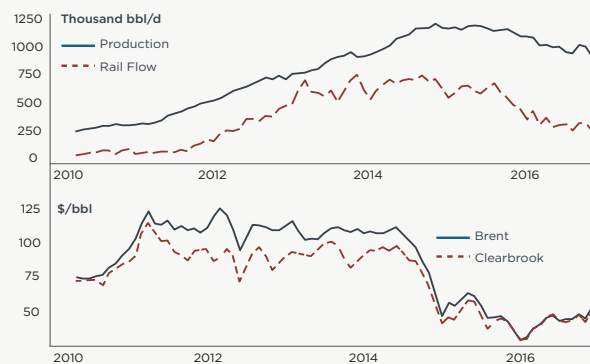
Further, transporting crude by rail has raised safety concerns as the number of accidents jumped nearly sixteen-fold during the 2010-2014 boom. The most prominent incident was the 2013 Lac-Mégantic crash in Quebec, which killed 47 people, destroyed 30 buildings in the town's center, and spilled 1.6 million gallons of oil. Since that crash, new safety regulations have been issued, and more could come.

Given the tradeoffs between rail and pipelines, what drove rail's sudden boom and sudden collapse? Some have interpreted rail to be a temporary “stopgap” measure, used to pick up the slack while new pipelines were permitted and built. This interpretation assumes crude-by-rail is only useful in accommodating an unexpected uptick in production in a new

place, and does not impact the long-run investment in pipeline infrastructure. The delays experienced by recent pipeline projects such as the Dakota Access Pipeline (completed in June, 2017) and the Keystone XL project (awaiting permits) are consistent with this story.

This paper explores an alternative view: The flexibility inherent with crude-by-rail makes it a more attractive option despite the higher per barrel cost. The authors explore the impact this “option value” could have on investments in oil pipelines.

**Figure 1 • Bakken Oil Production And Rail Exports Versus Brent And Clearbrook Oil Prices**



Note: The Brent price is an international waterborne crude oil benchmark price. The Clearbrook, MN oil price is the price Bakken producers can obtain by selling locally. Production and rail flow data are from the Energy Information Administration, and oil price data are from Bloomberg.

“As shipping crude oil by rail boomed with the rise of shale, then sank again, the ebb and flow caused many to think of rail as a temporary fix to pipelines’ long permitting and construction challenges. Our study finds that fluctuations in crude-by-rail volumes actually underscore rail’s flexibility. The ability to ramp rail shipments up and down is valuable to crude oil shippers, and it reduces incentives to make long-run investments in pipeline capacity.”

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## Research Design

To quantify the impact of crude-by-rail on pipeline investment, the authors developed a model in which crude oil shippers could use either a pipeline or a railroad to take advantage of whichever has the better price at the time. To build the model, they collected data from a variety of sources, including the prices of crude oil at major refining centers and Bakken crude oil, crude-by-rail flows, and rail transportation costs. The model is attuned to match market conditions in June 2014, when the Dakota Access Pipeline announced that it had received firm commitments from shippers to support a 470,000 bpd line. The researchers used historical oil prices to estimate the future distribution of crude prices that shippers faced at that time, and estimated railroad transportation costs as well as the pipeline tariff shippers committed to when signing long-term contracts.

The researchers captured in their model the essential tradeoffs between pipeline and railroad transportation of crude oil, with the central tension being between the low cost of pipeline transportation and the flexibility of rail. Their goal was to capture how factors such as transportation costs and expectations about future prices for crude oil affect firms' decisions on whether to invest in pipeline capacity versus rely on the railroads.

## Findings

**1. Rail transportation costs affect shippers' incentives to commit to pipelines.** A \$1 per barrel increase in the cost of rail would have caused more shippers to commit to pipeline contracts, such that investment in the Dakota Access Pipeline's capacity would have grown by 29,000 to 74,000 barrels per day above its actual 470,000 barrels per day capacity.

**2. The flexibility of rail transportation also affects shippers' incentives to commit to pipelines.** Without the ability of crude-by-rail to reach multiple destinations, the capacity of the Dakota Access Pipeline would have been 26,000 to 64,000 barrels per day larger.


**3. Policies that increase the cost of rail transport—such as regulations that target environmental and safety concerns—can affect pipeline capacity investment.** Accounting for railroad air pollution could cause the cost of rail to increase by \$2 per barrel. Had that increase been present at the time the Dakota Access pipeline was being built, the pipeline's capacity would have been at least 59,000 barrels per day larger.

## Policy Implications

While the policy conversation in recent years has focused on the environmental impacts of pipelines, this study demonstrates the effect environmental and safety regulations on rail would have on the long-term future of pipelines. Notably, policies such as emissions equipment regulation or emission pricing that would increase the cost of rail

shipping would lead to a long-run shift away from railroad transportation and toward pipeline investment.

Further, the findings from the study may apply to settings where there is an investment decision that involves a costly but flexible option and an option that requires large up-front commitments but is otherwise lower in cost. For instance, urban transportation planners must often choose whether to invest in dedicated light rail lines, which have large sunk costs that can translate to low per-passenger costs given sufficient ridership, or flexible bus networks. As another example, electricity is generated by both “baseload” plants (such as nuclear plants that have nearly zero marginal cost) and “peaker” plants that have low sunk but high marginal costs and can help serve stochastic electricity loads. The model developed in this study provides a conceptual framework that can be used to evaluate and intuitively understand how such tradeoffs are affected by factors such as relative costs, scale economies, and demand uncertainty.



“Beyond shedding light on the economics driving one of the most significant developments in the U.S. crude oil industry in decades, our study also shows how a costly but flexible transportation option can impact incentives to invest in durable infrastructure that is cheaper but requires large up-front commitments. This basic finding can be applied to many other settings involving similar trade-offs between technologies.”

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