Crude Oil Price Differentials and Pipeline Infrastructure

Shaun McRae*

May 12, 2017

ABSTRACT

Technological advances in oil production have reshaped the geography of oil markets in the United States. Areas with previously low or declining production, such as the Bakken shale region in North Dakota and the Permian Basin in western Texas, have experienced extremely rapid growth. However, the pace of change in oil production was not matched by construction of oil transportation infrastructure. Limited crude oil pipeline capacity meant that the price received by producers in many regions was much lower than the oil price at major market hubs. These price differentials reflected the higher cost of transporting oil by pipeline alternatives such as rail.

The price differentials created opportunities for new investment in oil pipelines. Between 2010 and 2015, the total length of crude oil pipelines in the United States grew from 54,600 miles to 73,200 miles, with two thirds of this expansion in interstate pipelines. Existing pipelines were reconfigured or expanded to match the new market conditions. Pipelines that had been used for other commodities (such as natural gas or refined products) were converted to carry crude oil. The new pipelines improved transportation access not only out of the Bakken region and the Permian Basin, but also from the Rocky Mountains, Great Plains and Midwest regions to the primary pipeline hub at Cushing, Oklahoma.

A small number of these oil pipeline projects have been extremely controversial, most notably the Keystone XL and the Dakota Access pipelines. In the popular perception, the "benefits" of these projects are represented by the value of the raw materials and labor used for their construction. The "costs" of the projects are environmental risks associated with potential oil spills from the pipelines.

*Department of Economics and Centro de Investigación Económica, ITAM. Email: shaun.mcrae@itam.mx.

This view misses the primary economic motivation for investment in transportation infrastructure: the reduction in trade costs. New oil pipelines have reduced the cost of transporting oil out of expanding production regions to market hubs. This means that oil producers in these regions face a lower discount to the world oil price for their production.

At an aggregate level, there appear to be large benefits from the expansion in the oil pipeline network. The production-weighted discount of the oil price received by producers in the United States, relative to a world price benchmark, has fallen from $28 per barrel in September 2011 to $5 per barrel in December 2016. Volumes of oil transported by rail have fallen from a peak of 35 million barrels during October 2014 to 13 million barrels during December 2016. Although these aggregate changes appear to be correlated with the pipeline network expansion, there may be other contributing factors. In particular, world oil prices have halved since 2014, and aggregate oil production in the United States has fallen by 9 percent from its peak.

This paper decomposes the economic benefits associated with investment in oil pipeline infrastructure. Expanded pipeline capacity reduces the price discount received by oil producers. In part, the reduced discount represents a transfer from local oil refiners to local oil producers, because the prices paid by local refiners for their crude oil inputs are higher. There is also a transfer from oil shippers to the oil producers, as shippers with access to the constrained pipeline capacity earned profits from the price arbitrage. Two other components of the reduced discount represent overall welfare gains for society. First, there is a reduction in transportation costs for the oil carried by the new pipeline instead of a higher priced alternative. Second, there is a small increase in oil production as the result of the higher producer price.

I quantify these economic effects at the level of each oil producing region. I construct a dataset of monthly pipeline capacity into and out of each region, incorporating publicly available information on the construction and expansion of the pipeline network. This data is combined with information on oil production, refinery capacity, pipeline tariffs, and pipeline flow volumes. There are two sources for producer prices: monthly average wellhead prices at a state level and daily crude oil commodity prices at major trading hubs.

I use this data to construct, for each exporting region, a monthly measure of excess supply relative to pipeline capacity. This is equal to production of the region, less the crude oil input capacity of the local refineries, less the pipeline capacity. I then estimate the price discount received by local oil producers as a function of the excess supply measure. When a new pipeline begins operating there is a decline in the excess supply measure, and in many

cases this is associated with a large reduction in the producer price discount.

I then use these estimates to simulate, for each region, the effect on producer prices of an increase in pipeline capacity. This is used to calculate the increase in surplus to oil producers, based on an assumption from the literature for the price elasticity of oil production. Similarly, the price change is used to calculate the reduction in surplus to oil refiners and oil shippers. Preliminary results show that most of the overall welfare gains are due to the reduction in shipping costs, although this gain is smaller in magnitude than the transfer in surplus from refiners and shippers to oil producers.

The oil transportation sector in North America has been completely transformed in the past few years. Large investments in transportation infrastructure have reshaped the crude oil pipeline network, providing access to world markets for the near-doubling in oil production since 2008. As quantified in this paper, these new pipelines have nearly eliminated the discount to world oil prices that many producers in the United States were facing between 2011 and 2014, leading to large improvements in oil producer surplus.