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Getting Crude to Market: Central U.S. Oil Transportation Challenges

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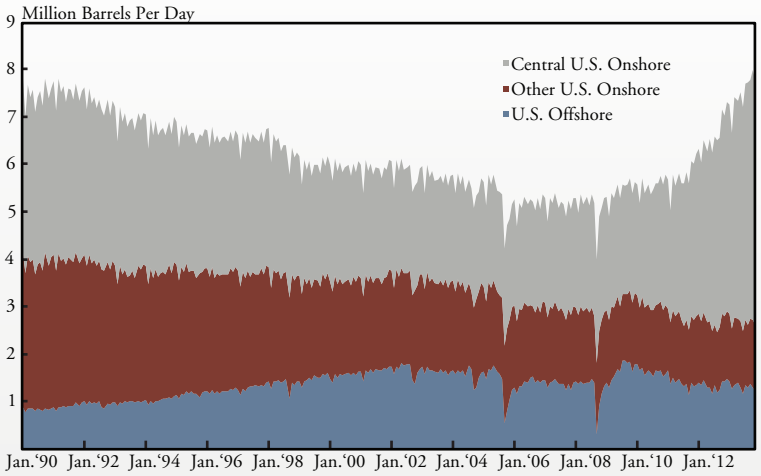
Crude oil production in the United States is booming. From early 2010, when the current surge started, to the end of 2013, U.S. production of crude oil rose nearly 40 percent. By 2016, production is expected to increase another 25 percent, which would make the United States the world's largest oil producer.[1] Most of this increase is occurring in the middle of the country, in places that did not previously have much production. Areas of North Dakota and some untapped areas of Texas, Wyoming and Oklahoma have recently become accessible because of high oil prices and advanced horizontal drilling techniques. However, increased production from these new "plays" has created a supply bottleneck because most existing oil pipelines are not able to handle the added volume. The bottleneck has both pushed down central U.S. crude prices relative to world prices and significantly increased the use of alternate modes of oil transport.

This article examines the evolution of oil transportation networks and the challenges faced in moving ever-increasing amounts of crude from the central United States. Two key recent trends are a boom in construction of pipelines and other infrastructure and a surge in transporting oil by rail (and to a lesser extent trucks and barges). Both trends hold promise for eliminating or greatly reducing the bottlenecks, while also boosting employment and income in areas where networks are expanding. These two trends, however, face regulatory, environmental and political pushback, as well as other challenges associated with a rapidly evolving U.S. oil industry.

The boom and bottleneck in central U.S. oil production

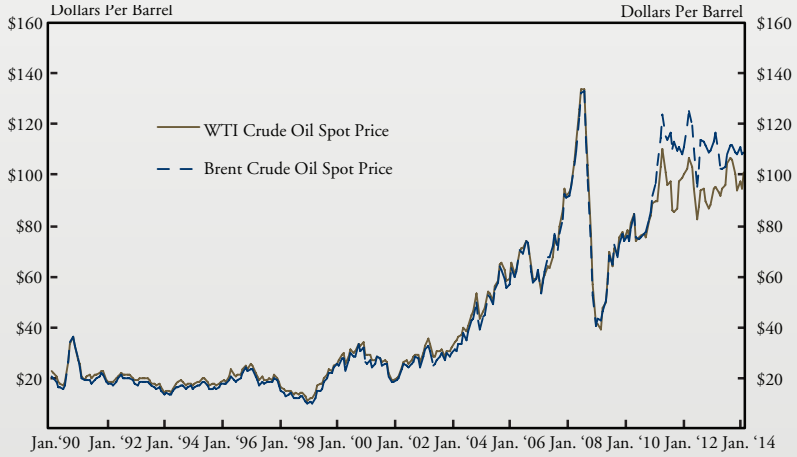
Prior to 2010, less than half of U.S. oil production occurred onshore between the Mississippi River and the Rocky Mountains. But by the end of 2013, production in this area had increased to more than two-thirds of the nation's total, with new oil plays in this area accounting for all of the rise in U.S. production since 2010 (Chart 1). Specifically, the two most productive recent oil plays—the Eagle Ford Shale in south Texas and the Bakken Shale in North Dakota—together account for more than three-quarters of the overall increase. Other

Chart 1: Monthly U.S. Production of Crude Oil



Source: Energy Information Administration.

Chart 2: WTI and Brent Crude Oil Prices



Source: The Wall Street Journal.

plays in the midcontinent region—including the Permian Basin in West Texas and New Mexico, the Niobrara Shale in Colorado and Wyoming, and smaller plays in Oklahoma and Kansas—account for another third of the increase in U.S. oil production, offsetting some production declines in Alaska and U.S. offshore wells.

This production surge has led to a glut of oil, especially at Cushing, Oklahoma, where most central U.S. oil pipelines meet and where the price is set for U.S. benchmark West Texas Intermediate (WTI) crude. From 2009 to 2013, petroleum stocks at U.S. storage facilities increased 10 percent, with two-thirds of the increase occurring at Cushing alone. Stocks at Cushing increased 50 percent in the period as it received more oil from the north and southwest than it was able to ship by pipeline to refiners on the Gulf Coast or elsewhere.

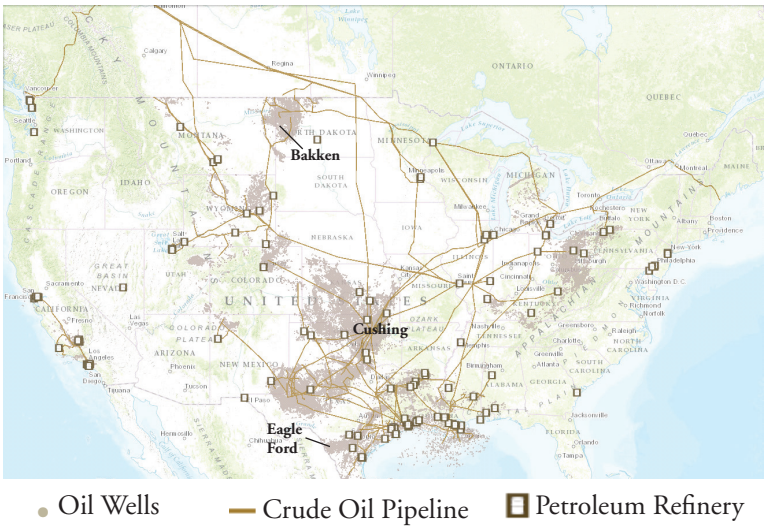
By 2011, the glut of oil had produced the first sizable spread between the prices of WTI and Brent North Sea oil, the international benchmark, with WTI trading at a considerable discount as opposed to a slight premium historically (Chart 2). From 1990 to 2010, WTI averaged $1.38 more per barrel than Brent, and only traded below Brent 10 percent of the time and never by as much as $5. But since January 2011, WTI has averaged nearly $15 less per barrel than Brent.

The recent evolution of U.S. oil transportation infrastructure

As the supply bottleneck and price discounting intensified at Cushing, it became clear the nation's oil pipeline, storage and refining infrastructure needed upgrading. Much of this infrastructure is far from the most productive oil plays, and some is configured to receive flows from a different direction, or simply is outdated. Even today, pipelines and refineries are largely situated near either the traditional oil fields of Oklahoma, West Texas and Louisiana, or near population centers on the Atlantic and Pacific Coasts, where international crude imports arrive to be refined in the United States (Map). In contrast, there is little permanent infrastructure near the Bakken fields in North Dakota and Montana or the Eagle Ford play in far south Texas.

To address these infrastructure needs, billions of dollars' worth of new projects—primarily pipelines and storage facilities—are planned or have started. For example, 1,165 miles of oil pipeline and related projects were set to be completed in the United States in 2013; completion of 2,597 miles is expected in 2014.[2] An additional 1,734 miles of pipeline are planned to start in 2014 and be finished in 2015 or later. Storage facility construction has also boomed in Cushing and elsewhere, and the flow direction of some major pipelines has been reversed to send oil from the central United States to the Gulf Coast. Refineries likewise have added some capacity, along with a few small new facilities to refine crude to a point that it can be exported.[3]

Map: Location of U.S. Oil Wells, Crude Oil Pipelines, and Refineries, February 2014



Source: Energy Information Administration.

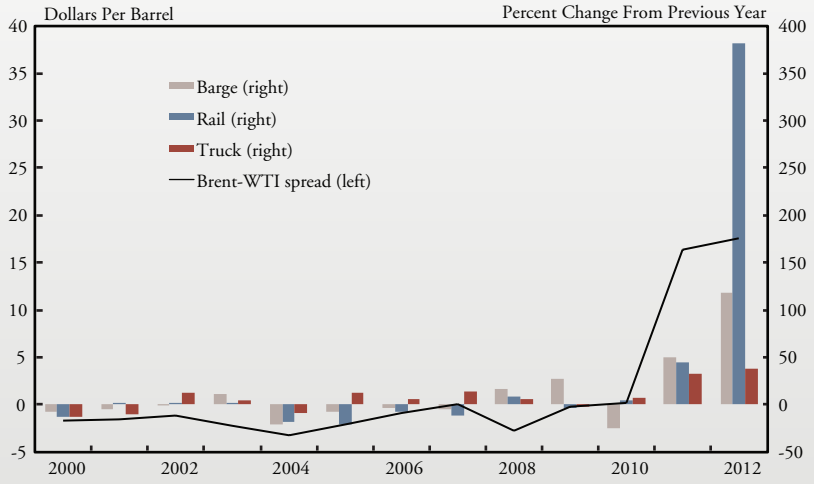
These new pipelines and facilities, and changes in the direction of flows, have begun to loosen some of the bottlenecks, and early evidence suggests that process may continue. For example, the spread between central U.S. and world oil prices, while still sizable, has been somewhat smaller in 2013 and early 2014 than in 2011 and 2012. However, these projects—especially new pipelines and refineries—beyond requiring significant investment and time, are by their nature fixed in place. They also typically require long-term contracts with producers to ensure cash flow for the duration of an expensive project. Such assurances are somewhat difficult to obtain given the nature of the current oil boom. Wells in the shale and tight oil plays that account for the bulk of recent production growth typically have much faster rates of decline than traditional fields, and thus may not be as long-lasting. As such, alternate modes of oil transportation—with higher operating costs but lower capital costs and greater flexibility—have emerged to take advantage of the price spread. These modes include barge, truck and rail transportation (Table).

As price arbitrage opportunities from the oil glut oil emerged in 2011, each alternate mode of transportation showed a significant increase in domestic deliveries to U.S. refineries (Chart 3). Barge transportation, the alternate mode with the lowest operating costs and only moderate

Table: Transportation Methods in the United States

	Pipeline	Rail	Barge	Truck
Capital Cost	Very High	High	Moderate	Low
Operating Cost	Very Low	Moderate	Low	Very High
Geographic Coverage	Limited to build network	Limited to rail network	Limited to navigable channels	Unlimited
Shipment Size	Very Large	Small to moderate	Moderate to Large	Very Small

Chart 3: Oil Price Spread and Alternate Modes Of Oil Transportation



Source: Energy Information Administration.

capital costs, was the fastest-growing alternate mode in 2011. And in 2012, barge usage doubled from 2011. While barges historically have carried little crude oil, vessels outfitted to transport chemicals can be refitted relatively easily to transport oil.

Initially, much of the oil-by-barge traffic was on the Mississippi River, taking oil from the northern Plains to the Gulf of Mexico. Barge traffic now is also increasing on the Intracoastal Waterway in Texas, taking Eagle Ford Shale oil from its nearest port—Corpus Christi—north to refineries on the Texas coast and in Louisiana. In fact, domestic crude oil transported by barge to refineries in the Gulf Coast more than tripled from 2010 to 2012. Barges, however, much like pipelines on fixed routes, are constrained to navigable waterways that largely are inflexible to expansion. And thus much of the future growth of oil traffic by barge may be limited to niche markets.

Oil transportation by truck, the alternative with the lowest startup costs and broadest potential geographic coverage, grew more than 30 percent in 2011. Despite offering a short-term solution, truck transportation has the highest operating costs of the alternate modes and, given its small capacity per shipment, is the most energy-intensive mode. Even though oil-by-truck transport grew another 30 percent in 2012, it didn't surge like other modes, and thus may be destined to remain primarily a provider of oil to other modes of transportation rather than refineries.

The fastest-growing alternate mode of oil transportation has been railroads. Rail transportation is somewhat more expensive than barges, and not quite as flexible as trucks. But overall, as an option during pipeline construction and periods of high oil-price differential, rail may have the best combination of attributes of the alternative modes. The use of rail grew much faster than either barges or trucks in 2012 and that strong growth continued in 2013, according to industry data. And as other shale plays emerge, especially if they are far from the coasts, rail may become even more important to the oil transportation network.

While most oil by rail is transported directly to refineries in the Midwest or the coasts, some rail transportation—like truck transportation—is used to connect with other less expensive modes with limited

geographic flexibility, including pipelines but also barges. For example, some rail cars from North Dakota go to Mississippi River ports where barges take the oil to the Gulf of Mexico; others go to ports in Washington where tankers take oil to San Francisco area refineries.

Environmental, safety and political uncertainties

As each mode of oil transportation has grown, so have concerns about safety and the effect of each on the environment. One project that has received significant scrutiny is the Keystone XL pipeline. Proposed in 2008, the pipeline would extend from Canada's tar sands through the Plains states to the Gulf of Mexico. Keystone's southern leg, from Cushing to the Gulf, became operational in January 2014. But construction of the northern leg, which crosses the international border and thus requires presidential approval, remains delayed due to concerns about the relatively carbon-heavy quality of the oil transported, disputes over possible paths it might take through the Plains and how frequently spills might occur. Analysts generally expect a decision sometime in 2014.

In addition to the Keystone project, other pipelines have been delayed or rerouted due to landowners' concerns about spills on their properties. But more recently, the environmental and safety debates have shifted to oil-by-rail transport. This follows several recent oil train derailments, most notably on July 6, 2013, in Lac-Mégantic, Quebec—just north of Maine—that caused an explosion and killed 47 people. This incident has called into question the safety of older rail cars—known as DOT-111s—that still handle a majority of oil-by-rail transport in the United States.

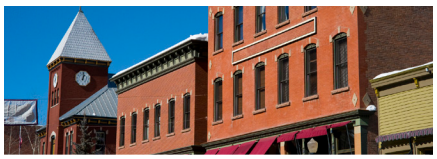
Responses to concerns about oil-by-rail safety have come recently from the rail industry and governments. Rail car manufacturers have greatly ramped up production of safer cars, and some railroads have raised their own standards for the cars they use to carry oil. In addition, in January 2014, transportation safety boards in both the United States and Canada suggested enhanced safety rules for oil rail cars. Then in February, the U.S. Department of Transportation issued an emergency order requiring stricter classifications and closer scrutiny of petroleum carried by rail cars. Some officials now expect new standards for oil tank cars to be implemented by the end of 2014. These actions may affect rail transportation of oil in the near term, as well as modify how refineries receive crude oil or even temporarily disrupt its flow—potentially affecting gasoline prices.

Refineries and oil transporters also face uncertainty over possible changes to U.S. laws that restrict ocean shipments of petroleum and petroleum products. U.S. exports of crude oil have been prohibited since the 1970s, and coastal shipments between U.S. ports must be made by U.S. ships carrying just U.S. products. As such, some analysts expect a glut of U.S. oil to persist until refineries are able to refine all of the oil coming out of the central United States. Although there have been congressional hearings this year about easing restrictions, most analysts do not expect any significant changes in 2014.[4]

Implications for households and the economy

Even with the continued discounting of central U.S. oil prices relative to world oil prices, there has been no measurable effect on Midwest gasoline prices relative to other regions of the country. U.S. gasoline prices have closely tracked Brent oil rather than WTI in recent years, and wholesale gasoline prices in the Midwest have not differed notably from prices across the country. However, consumers in the central United States do not appear to have captured any of the potential benefit of the region's lower oil prices.

Despite lower oil prices in the region, recent studies have shown Midwest gasoline prices have not varied from other regions because some gasoline in the Midwest is still imported from refineries on the coasts.[5] Midwest refineries have been operating at or near



capacity, causing much of the region's crude oil to be transported out of the region and then returned as gasoline. Refineries on the coasts, meanwhile, largely pay the world price for crude since the United States is still a large net importer of oil. This should mean that even when central U.S. oil prices return to or near international levels, gasoline prices in the Midwest will not rise more than other places.

Although the central U.S. oil boom has not resulted in lower gasoline prices, the regional economy has benefited from increased employment and incomes in areas with direct or indirect involvement in oil and gas production or transportation.[6] This includes areas with heavy drilling activity, pipeline and other infrastructure construction or manufacturing, oil transportation ports, as well as central U.S. cities with oil and gas headquarters or large regional offices, such as Houston, Dallas, Oklahoma City, Tulsa and Denver.

Summary and conclusion

Oil transportation in the central United States is undergoing an historic realignment in response to the recent shale oil boom. Rising oil production in the middle of the country increased inventories due to inadequate pipeline capacity, which caused a spread between the benchmark U.S. crude oil price in Cushing, Oklahoma, and the global benchmark, Brent. These motivated the usage of alternate but costlier modes of transportation, such as rail, as well as increased pipeline capacity.

But even as pipeline capacity has risen, continual growth in oil production has caused the oil glut and the price spread to persist. As such, usage of alternate transport modes has grown, providing a boost to economic activity in areas where it occurs. And if new shale plays are tapped in other places not connected to pipelines, the trend in the usage of alternate transport modes could continue for some time. Meanwhile, some safety and environmental concerns have emerged about both pipelines and oil-by-rail transport. These concerns, along with restrictions on U.S. oil exports, have created some uncertainty about how long the central U.S. oil glut might persist.

ENDNOTES

[1]Energy Information Administration, 2014 Annual Energy Outlook, Early Release, Dec. 16, 2013.

[2]*Oil & Gas Journal*, Feb. 3, 2014.

[3]The United States has prohibited exports of pure crude oil since 1973, when controls were implemented to help prevent energy shortages and price spikes. Exports of more refined petroleum are allowed, and some small facilities have recently been constructed to refine crude oil to just the minimum standards for export.

[4]For example, The Rapidan Group, "Senate Holds Hearing on Crude Oil Exports," Jan. 31, 2014

[5]For example, S. Borenstein and R. Kellogg, "The Incidence of an Oil Glut: Who Benefits from Cheap Crude Oil in the Midwest?" *Energy Journal,* 35 (Jan. 2014), pp. 15-33.

[6]As found, for example, by IHS Consulting, "America's New Energy Future: The Unconventional Oil and Gas Revolution and the U.S. Economy, Volume 2: State Report"