The Permian basin and the rebound in U.S. crude oil production

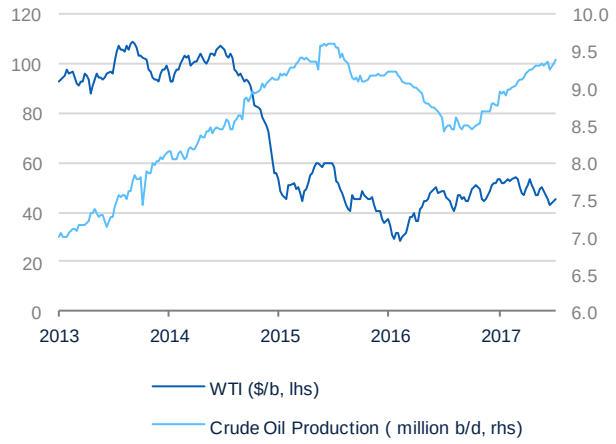
Marcial Nava

18 July 2017

Introduction

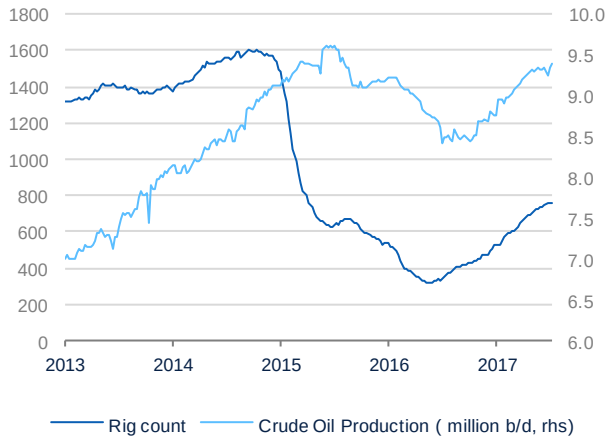
U.S. crude oil production continues to increase, complicating efforts made by OPEC and its partners to stabilize the market through output cuts. After reaching a bottom in July 2016, U.S. production has surged by 969,000 b/d to 9.4 million b/d as of July 7 2017.[1] At this pace, production could surpass its previous peak of 9.6 million b/d sometime in what remains of 2017. This would happen in a lower price environment. In fact, the last time production reached 9.6 million b/d (June 2015) WTI prices averaged $56/b. In contrast, if production were to reach 9.6 million b/d in the following months, it will most likely do so with WTI prices between $45/b and $50/b. The purpose of these brief is to explore the nature of the ongoing rebound in U.S. crude oil production.

Figure 1: U.S. crude oil production and oil prices



Source: Source: BBVA Research with data from EIA

Figure 2: U.S. crude oil production and active rig count



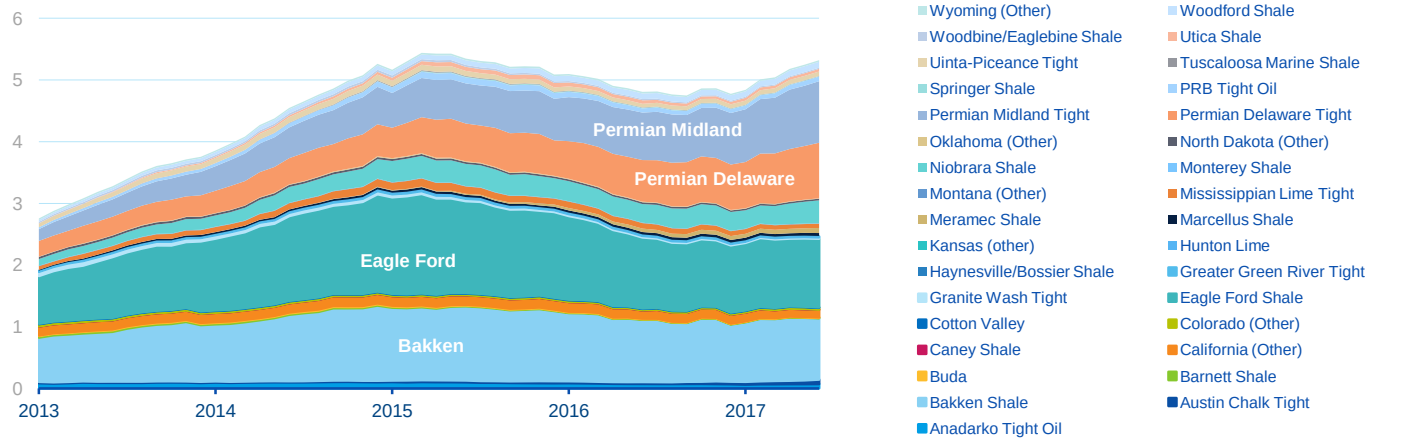
Source: BBVA Research with data from EIA

Efficiency in the face of adversity

About three quarters of the rebound in crude oil production has happened onshore, mainly in the Permian basin. Located in the western part of Texas and the southeastern part of New Mexico, the Permian Midland and the Permian Delaware sub-basins accounted for 93% of the net increase in shale oil production between July 2016 and May 2017, based on data at the well level compiled by Rystad Energy.

1: Source: Energy Information Administration

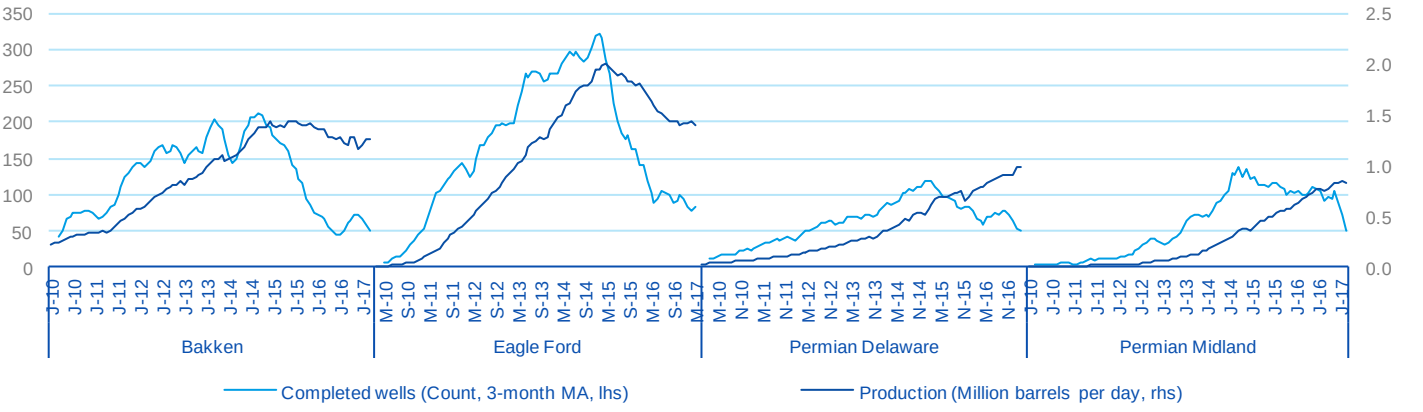
Figure 3. U.S. Light Oil Production by Shale Play (million b/d)



Source: BBVA Research with data from Rystad Energy. 2017 data may change as new information becomes available.

What makes the Permian so special? First and foremost is the geology. The Permian basin is comprised by a series of "stacked plays". This means that a single well can produce oil from different layers of rock in different geological zones.[2] The region has been producing oil for decades, but the recent application of hydraulic fracturing and horizontal drilling has revitalized its potential. This, together with local refining capacity, proximity to the Gulf Coast refineries, and existing pipeline infrastructure has made the Permian the "place to be" for the oil and gas industry. Not surprisingly, production has tripled since 2008. Currently, the region concentrates about 40% of total horizontal active wells and 33% of crude oil production in the 48 lower states. More than half of the active rigs in the seven most prolific shale regions are located in the Permian. The exceptionality of the Permian manifested after oil prices collapsed in mid-2014. Figure 4 shows that contrary to the Bakken and the Eagle Ford –the two largest producing regions along with the Permian- production in both the Permian Delaware and Permian Midland sub-basins never declined. Moreover, Permian production figures contrast with the evolution of horizontal active wells, which continue to decline according to Rystad data.

Figure 4. Active horizontal well count and crude oil production

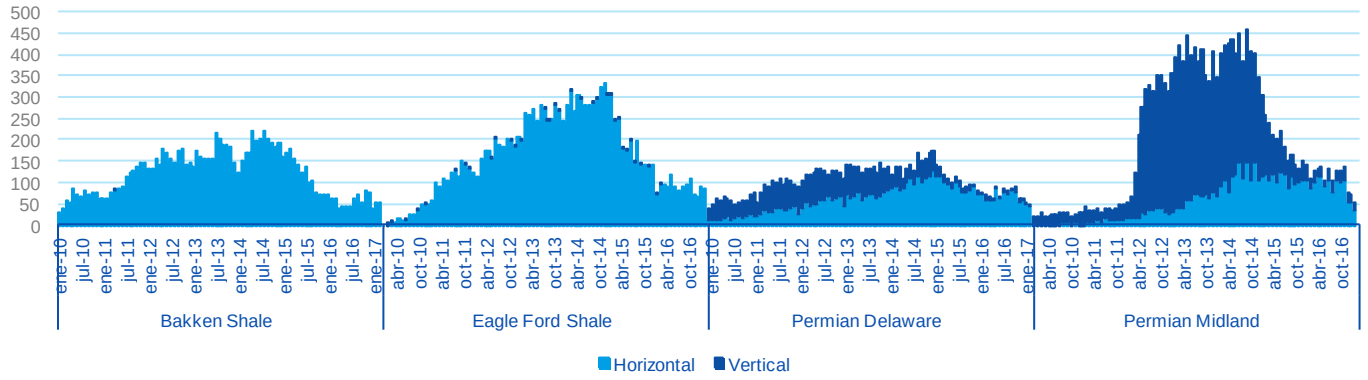


Source: BBVA Research with data from Rystad Energy. 2017 data may change as new information becomes available.

2: Chevron. "The Permian Basin. American Energy Powerhouse." https://www.chevron.com/projects/permian

One explanation for the continuous increase in the Permian's crude oil production is the much larger stock of vertical wells compared to the Bakken and the Eagle Ford where wells are predominantly horizontal. Vertical wells are less costly to develop, which make them a viable alternative in periods of low prices. In addition, vertical wells also have slower declining rates than horizontal wells and do not need as many new wells to offset declines in legacy production.[3] Moreover, the successful application of recovery techniques such as water flooding and carbon dioxide injection boosted the productivity of these wells.

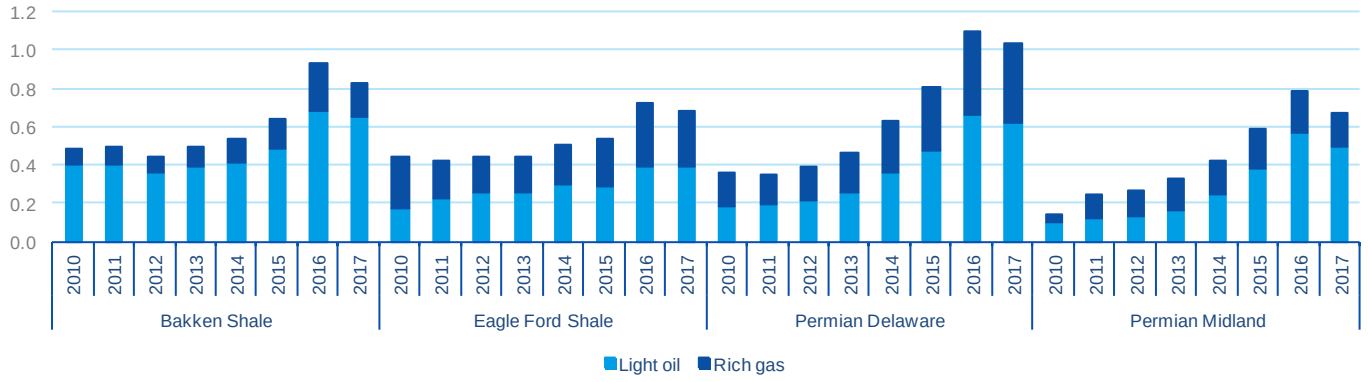
Figure 5. Active Well Count



Source: BBVA Research with data from Rystad Energy. 2017 data may change as information becomes available.

Meanwhile, even as the share of vertical wells declined, production continued to increase suggesting that the remaining horizontal wells became more productive. Estimated well ultimate recovery (EUR) rates or the amount of oil and gas that can be extracted at the end of the well producing life have grown exponentially since 2010 in both Permian Midland and Delaware, surpassing the average EUR of the Eagle Ford and, as it is the case of Delaware, equating the average EUR in the Bakken.

Figure 6. Estimated Well Ultimate Recovery (million boe)

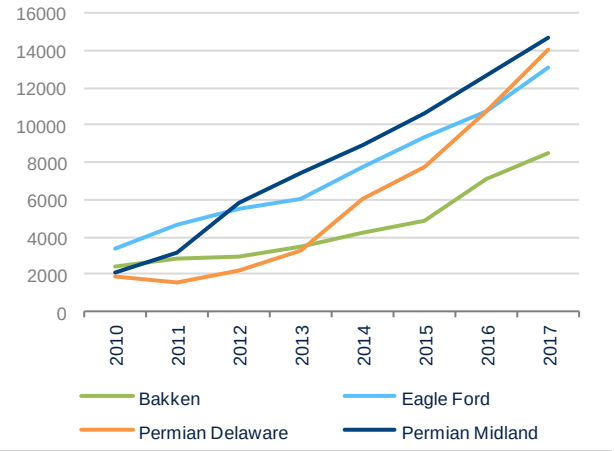


Source: BBVA Research with data from Rystad Energy. 2017 data may change as information becomes available.

3: Energy Information Administration. "Initial production rates in tight oil formations continue to rise." Today in Energy. February 11, 2016.

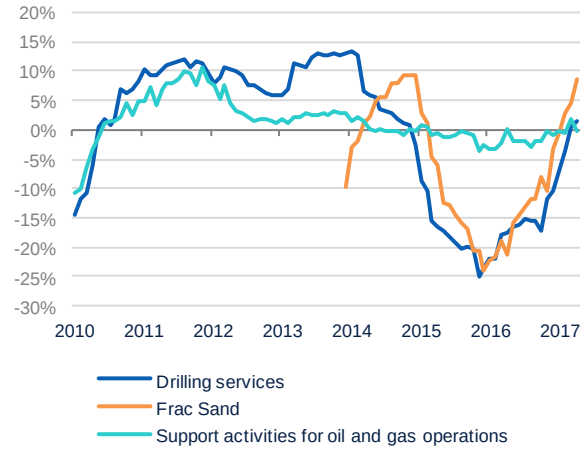
Several factors explain the productivity gains in the average horizontal well in the current low price environment. These factors are not exclusive to the Permian; however, they have added to the comparative advantages of the region and contributed to boost its attractiveness. Among them is the systematic application of "high-grading" or the process of selecting and developing the most profitable assets while keeping an inventory of drilled but uncompleted wells that would be retaken when prices go up. The use of high-grading requires operators to have a deep understanding of the geological and geophysical characteristics of the acreage. Because building this knowledge implies substantial expenses on sophisticated seismic surveys, the benefits of high-grading tend to be reaped for the most part by big companies with ample resources and several alternatives to choose from. Another factor behind the observed productivity gains is the dramatic decline in the cost of oilfield services and proppants such as frac sand. Figure 7 shows that proppant intensity has followed an upward trend that became steeper since 2014 in the Permian Delaware. Higher proppant loadings facilitate the extraction of oil and improve the overall performance of the wells.

Figure 7: Proppant intensity per well (thousand pounds)



Source: Source: BBVA Research with data from Rystad Energy. 2017 data may change as information becomes available

Figure 8: PPI (yoy change, Dec 2012 = 100)

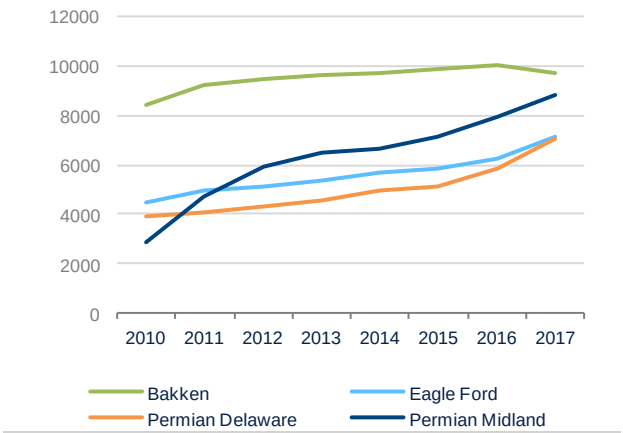


Source: BBVA Research with data from BLS

Adapting to a low price environment has also encompassed a good dose of technology. Operators have been able to use longer laterals, which allow them to maximize extraction from a single place without having to drill further wells. The average lateral length in the four analyzed regions has gone from 3,700 feet in 2010 to 6,669 feet in 2016. The use of laterals as long as 10,000 feet or more is becoming more frequent. Moreover, the position of the fracks along the lateral can now be optimized in contrast to the application of standard intervals.[4] Also, rig mobility has facilitated pad drilling and has led to the reduction of drilling times. Other innovations like more powerful equipment (drill bits, sensors, pumps, etc.), and improved logistics have also contributed to reduce drilling costs.

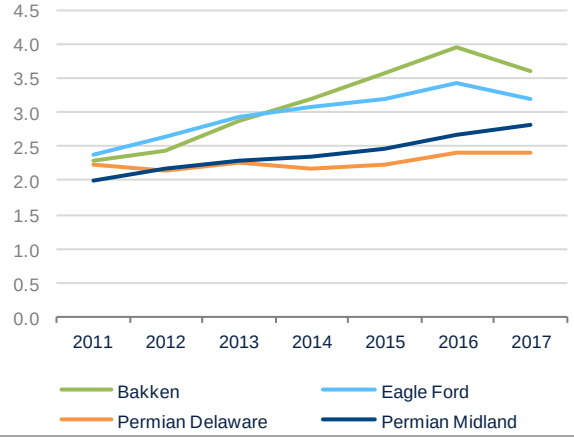
4: Curtis, Trisha. "Unravelling the U.S. Shale Productivity Gains." The Oxford Institute for Energy Studies. WPM 69. November, 2016

Figure 9: Average lateral length per horizontal well (feet)



Source: Source: BBVA Research with data from Rystad Energy. 2017 data may change as information becomes available.

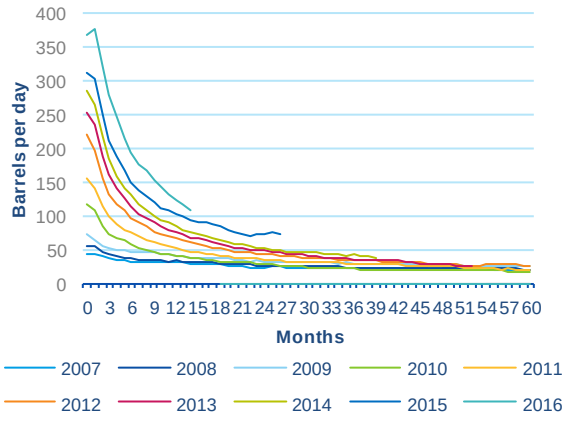
Figure 10: Average wells per pad



Source: BBVA Research with data from Rystad Energy. 2017 data may change as information becomes available

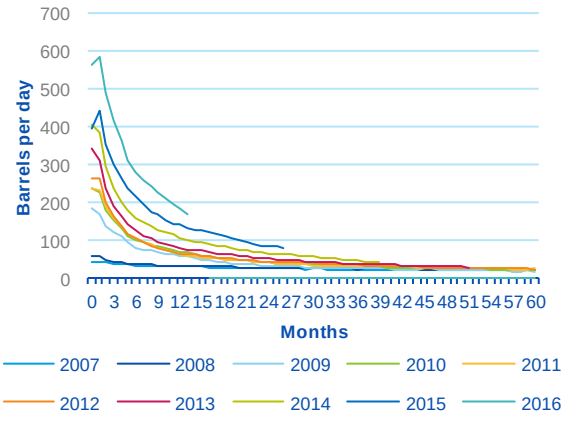
As technology and drilling methods improve, operators have been able to extract more oil during the first months of the well. Average daily production has improved across the country and through the years meaning that wells being drilled today are more productive than those drilled in previous years. Increasing initial production rates have allowed companies to generate positive cash flows faster, increasing their chances of surviving lower oil prices. In 2016, initial production rates were higher in the Permian (figure 12) than the national average (figure 11). Although the overall performance of initial production seems to be driven by structural factors, 2016 figures are also influenced by the effects of high-grading as companies developed only the most productive wells leaving aside those with lower initial production rates. If these wells were brought to production, the average initial production rate would be lower than what the data reveals.

Figure 11: Average daily production per horizontal well (U.S.)



Source: BBVA Research with data from Rystad Energy.

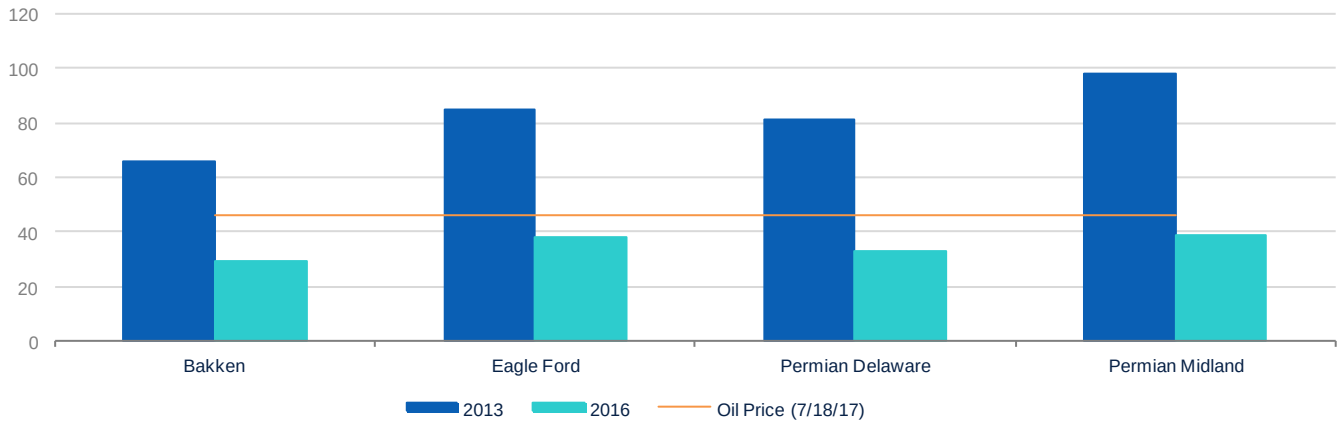
Figure 12: Average daily production per horizontal well (Permian)



Source: BBVA Research with data from Rystad Energy.

All of the above trends have resulted in lower breakeven prices that remain comfortably below spot prices (figure 13). Out of the four analyzed regions, both Permian Midland and Delaware have experienced the strongest declines in breakeven prices, which are $39/b and $33/b, respectively.[5] This represents a drop of 60% in three years and the narrowing in the dispersion of breakevens.

Figure 13. Breakeven Prices ($ per barrel)



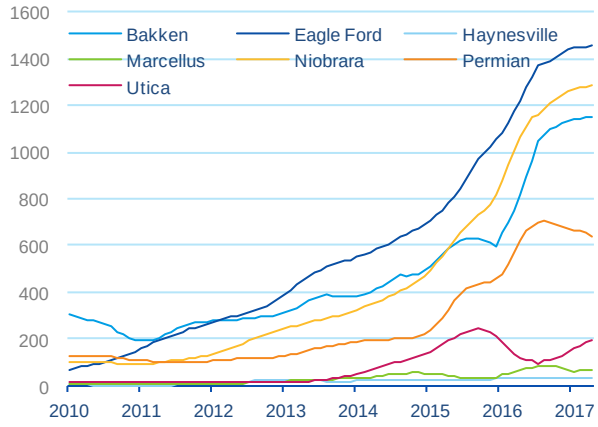
Source: BBVA Research with breakevens from Rystad Energy published in Mlada, Sona. "North American Shale Breakeven Prices: What to Expect from 2017?" Oil & Gas Financial Journal. February, 2017. Pages 16-18.

How sustainable is the rebound in U.S. production?

On the one hand, in contrast to the general optimism displayed by producers, oil field service companies and proppant suppliers have questioned the quality of the production rebound, arguing that there is no meaningful innovation or technological breakthrough behind it but a drastic decline in production costs. This would imply that the response of operators to the decline in oil prices was predominantly cyclical. Therefore, production would continue to increase if input costs remain low or if they increase in tandem with oil prices. In this scenario, U.S. oil production would be mostly determined by global demand and supply dynamics. On the other hand, a structural response such as the successful implementation of new technologies would generate long-lasting efficiency gains. In this scenario, participants would be able to maintain profitability and increase production even if oil prices remain low. In this environment, U.S. production would continue to impact global markets.

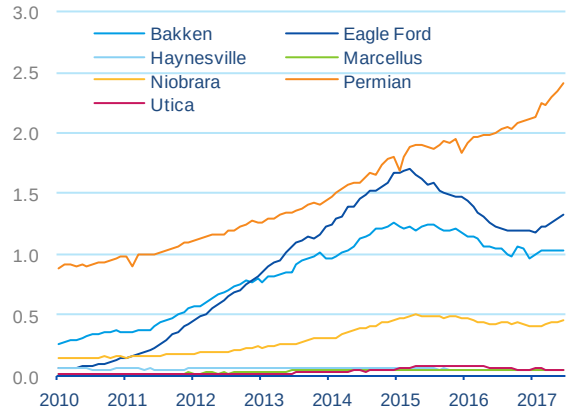
5: Mlada, Sona. "North American Shale Breakeven Prices: What to Expect from 2017?" Oil & Gas Financial Journal. February, 2017. Pages 16-18.

Figure 14: New Well Oil Production Per Rig (b/d)



Source: BBVA Research with data from EIA

Figure 15: Total oil production (b/d)



Source: BBVA Research with data from EIA

The structural response can also be analyzed from a technology life-cycle perspective. Since 2010, new well oil production per rig has mimicked the behavior of an innovation S-curve (figure 14)[6], which is commonly observed in the manufacturing and IT sectors. The "ferment" or learning portion of the curve lasted about four years after which there was a steep "take off" that peaked in the second half of 2016. Since then, the curve has flattened, or declined as it is the case in the Permian, suggesting that additional productivity gains are becoming increasingly difficult to achieve. If this trend continues, production could peak if output coming from new wells is not enough to offset the decline in legacy production. So far, this doesn't seem to be the case and total production, the sum of new plus declining legacy output, continues to increase.

However, lower productivity also suggests that operators may have exhausted the benefits of current technologies, and that a new dose of ingenuity may be needed in the future. In fact, the EIA Drilling Productivity Report reveals a widespread slowdown in the new well production per rig. If the S-curve is to be believed, the industry may be entering a "maturity" stage that will be followed by "discontinuity" and the emergence of a new "ferment" stage characterized by technological novelties.

For oil production in the Permian, despite its remarkable performance, additional concerns have emerged about the capacity of existing transportation infrastructure to move crude oil to the refining centers as suggested by the difference between the price of the West Texas Intermediate at Midland, TX and the West Texas Intermediate at Cushing, Oklahoma. The difference has expanded in recent months suggesting that Permian crude oil is being sold at a discount. Although the difference is widening (currently around $1.15/b), it is still below the $4/b and $7/b experienced in 2012 and 2014 respectively, two years in which pipelines and refining capacity struggled to absorb a rapid increase in production and excess crude oil had to be moved by truck or rail. However, as new pipelines were added, the gap between the two benchmarks narrowed quickly. Recent additions to existing pipelines as well as new projects are likely to expand

6: Tertzakian, Peter. "Shale Efficiency Has Peaked…For Now." Oil Price.com. June 14, 2017.

transportation capacity in the following years. Moreover, the lifting of the export ban would be a plus for the Permian given its proximity to the Gulf Coast terminals.

Bottom Line

The recent rebound in U.S. production is a combination of cyclical and structural factors. High grading has been a key strategy to survive the collapse in oil prices, allowing producers to focus on the most productive assets, while keeping an inventory of uncompleted wells until prices return to more profitable levels. The efficacy of high-grading was amplified by a substantial decline in the cost of oilfield services and proppants. These together with better understanding of the rock, and better completion designs that involved the use of longer laterals, optimal frack distribution, and higher proppant intensity have allowed the industry to come out of the crisis in a solid position.

However, challenges remain as increasing U.S. production –and stable demand growth- continues to put downward pressure on oil prices, testing the ability of some operators -particularly small ones- and their suppliers to remain cash flow positive for longer periods of time. Another challenge consists in how to prevent the marginal productivity of current technologies from moving to or below zero. Although difficult, there is a high probability that these challenges will be surmounted given the industry's proven record of ingenuity and innovation.