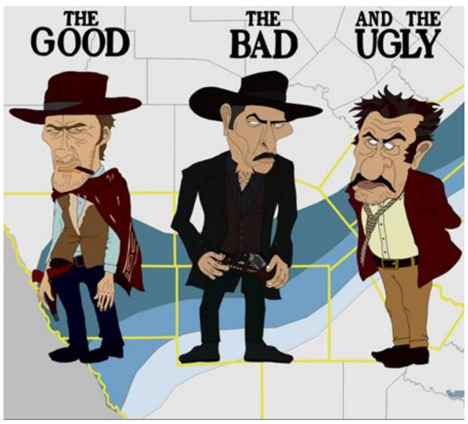
The GOOD, the BAD and the UGLY

The Dynamics of U.S. Production Declines and Eventual Rebound

Eagle Ford Basin



- **U.S. shale oil production is declining, but basin-by-basin trends vary significantly, reflecting the dynamics of local producer economics.**
- **The economic geography of oil and gas production in the U.S. has fragmented, opening a wide rift between high and low quality E&P assets.**
- **Consequently, any projection of future output requires detailed analysis of localized production economics.**
- **Overall crude production will rebound when favorable economics return to a critical mass of local producing areas.**
- **This RBN Drill Down report addresses what the fragmentation of U.S. shale economics means for today's output declines and what it implies for an eventual resumption of production growth.**
- **Differences between good, bad and ugly wells are explained by examining the diversity across the Eagle Ford basin and within one specific Eagle Ford County – La Salle.**

1. Introduction

U.S. onshore oil production from shale is finally succumbing to the impact of low crude prices. Five years ago, before the Shale Revolution reversed years of falling domestic oil production, that statement would have hardly raised an eyebrow. But after an 85% increase in production between early 2010 and April 2015, those words are sobering. Overall production is down from a peak of 9.7 MMb/d in April 2015 to just over 9.0 MMb/d (March 2016), and despite the recent jump in oil prices above $40/bbl, the rate of shale oil decline appears to be accelerating.

Critically important questions remain, however, and the answers to these questions will have profound effects on the oil and gas industry. How fast will shale production fall off? Which shale basins will be hit the hardest? And the most important question of all - how much will oil prices need to rise to reverse those declines?

The answers to these questions can only be addressed by understanding three key market factors that impact shale production: a) the decline rate of existing production, b) the economics of new well development, and c) the outlook for new producing wells based on the behavior of oil and gas producers. And, of course, that behavior is based on a producer's financial circumstances at a point in time.

These three market factors can be used to create a production forecast that provides the answers to our questions. At one level it is a fairly simple process. Each of our factors can be analyzed and projected:

- Using production volumes from existing wells and the expected rate of decline of those wells, we can forecast a base level of production volume. Call that factor "A". To the production volumes from existing wells we then need to add production from new wells.
- That gets us to factor "B". Producers drill wells that "make money". In this context, the words "make money" generally mean wells that generate attractive rates of return--the percentage return on investment from drilling a well. If we know which wells generate those attractive rates of return and we know how many wells could be drilled in a given area (proved and undeveloped drilling locations), we can estimate how many wells likely will be drilled--the "well count". Almost...
- Almost, because we must also incorporate factor "C" – the relative drilling economics of particular wells - that depend on several other considerations, such as the availability of corporate funds to drill the well, other wells competing for those funds--that is, are better returns available in other basins? --and improvements in those returns that producers may be able to achieve through lower costs and better well performance.

By modeling these factors, we can arrive at a production forecast. By running various scenarios through our model, we can develop answers to our questions regarding how, when and where U.S. production is likely to decline.

Of course, it takes a lot of data and a number of assumptions to create a mathematical model that incorporates these factors. And, as might be expected, the most unpredictable and economically sensitive of these assumptions is price. If the price of oil is higher, producers will realize higher rates of return and consequently drill more wells. That will result in growth in production volumes. This is the market environment that producers enjoyed from 2010 through late 2014, and that drove U.S. production to 9.7 MMb/d.

If crude oil prices are lower, as they are today, you might think that rates of return would be proportionally lower. But this is not necessarily so. If producers are able to significantly reduce the cost of drilling a well, and if they are able to get more volume out of that well, they can continue to achieve reasonably attractive returns even in the face of lower prices. That was the market environment from late 2014 to the end of 2015, when "resilient" U.S. producers maintained production growth even in the face of much lower prices.

But lower costs and higher volumes can only go so far to offset lower prices. At some point, the ability of producers to continue offsetting price declines hits a wall. Service providers simply cannot reduce their costs below some finite point. And there are other barriers to further enhancements to well economics. Producers have already implemented significant efficiency improvements, reducing costs. Likewise, well performance increases have been achieved. Those enhancements are already "baked into" today's production economics. Further enhancements are likely to be more difficult.

So with the still lower crude oil prices seen in early 2016, the economic impact on production economics cannot be so readily offset by further reductions in costs and improvement in well performance. The implication is that the economics of drilling new wells has deteriorated, slowing or even stopping drilling programs. That is the environment facing most producers in 2016.

1.1 No Well Completions = Production Declines

No Well Completions = Production Declines. That is one equation we can be sure of: If no new wells are completed, the natural decline rate of existing wells will result in falling production. However, if ***some*** new wells are completed, and if those wells are extremely productive, the new production from these new "super wells" might be enough to offset the decline from existing wells.

To forecast production, we estimate how many wells producers are likely to complete based on a given price outlook. Using this estimate for prices--together with all the other factors that go into a production economics model--we can compute a rate of return for prospective wells. This rate of return is the basis for estimating how many new wells will be completed[1]. When this result is plugged into a model that incorporates the estimated production from each new well plus production from existing wells, voilà, we have our production forecast.

As you might expect, there is a lot of number crunching before we get to "voilà". The chief difficulty comes from the economic diversity across different basins and within individual basins. For example, well costs vary according to the depth of formations and the length of laterals. Well productivity varies based on the geology of the formation and characteristics of the rock. Prices differ based on the costs of getting the production to market. The variability in producer economics from basin to basin is significant. Within each basin, each geographic area is different. And within each area there can be significant differences between individual wells. To model production, therefore, we must have a thorough understanding of production economics at some relatively granular level of aggregation, as well as an understanding of expected behavior of producers at that level of aggregation.

That gets us to an inconvenient truth about production forecasting in today's low price environment: *The economic geography of oil and gas production in the U.S. has fragmented.*

1.2 The Good, the Bad and the Ugly

There have always been "good basins" where the economics at any given price level support significant drilling activity, the "bad basins" where prices are somewhat below the economic threshold of drilling investment, and the "ugly basins" where drilling makes no economic sense whatsoever. What makes a basin good, bad or ugly is the combination of well performance (volume), well cost (drilling cost, completion cost, operational costs, financial costs) and net price back to the wellhead (netback) for any given well or group of wells. These factors are the key inputs to a producer's economic calculations and determine the producer's rate of return--and thus the incentive (or lack thereof) to drill and complete new wells. For bad and ugly basins, the economics do not necessarily mean that zero wells will be drilled and completed, but instead that the economics do not support investment in *most* wells. (Sometimes wells are drilled and completed for contractual and lease-retention reasons that are only marginally supported by production economics.)

[1] Note that the key here is not the number of wells drilled, but instead the number of wells completed. The reason for this distinction is a complicating factor in the process of forecasting production - the DUC problem, which stands for Drilled but UnCompleted wells. The issue is that some wells are drilled but not completed right away. They do not produce hydrocarbons until they are completed. Completion consists of hydrofracturing the well and hooking it up for production. Some wells are drilled to hold the acreage before a lease expires, or to make use of drilling contracts that are too expensive to cancel. Completions are relatively costly, and some completions are delayed while oil prices are low. While the number of DUCs can be estimated, the rate at which DUCs will eventually be completed is difficult to determine. As a result, the DUC issue throws an additional element of uncertainty into production forecasting.

The decline in prices has amplified the differences between the Good, the Bad and the Ugly. When crude oil was selling for $100/Bbl, most crude wells in the major shale basins realized positive rates of return—and some were much better than others. However, even most of the weaker producing areas enjoyed positive returns. Thus even producers in those weaker areas could eke out some level of profitability. That is no longer the case. With crude oil prices in the $30s-$40s, there now are large portions of all the major basins where the producer returns are negative, and in some cases well into the red, far below any rational threshold for new drilling activity.

The implications are profound for our basin-level production analysis:

- Drilling continues in the good parts of good basins, so production from the new wells has the potential to maintain or increase total production from the area.
- Drilling slows in the bad basins, and in the bad parts of good basins; consequently, existing production falls, thus total production declines.
- Drilling grinds to a halt in the ugly parts of basins, so production from those parts of the basin decline rapidly.

The bottom line is that a production forecast for any given basin must consider the mix of the good, the bad and the ugly within the basin. When the wells in any geographic area fall far enough below the economic threshold for producers, most if not all drilling will eventually stop. When this occurs, the only factor left to determine how fast production falls is the rate of decline for existing wells. That economic threshold and the decline rate of existing wells are both highly dependent on the geography--in fact, the geology--of those wells.

1.3 Rift in Energy Markets

The oil price collapse has been an earthquake in the energy markets, opening a wide rift between high quality "good" assets, breakeven "bad" assets, and ruinous "ugly" assets. The consequences will impact energy markets for decades to come. This RBN Drill Down report addresses what the fragmentation of U.S. shale economics means for today's production declines and what it implies for an eventual resumption of production growth. We demonstrate the differences between good, bad and ugly wells by examining the diversity across the Eagle Ford basin and within one specific Eagle Ford County – La Salle.

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