Marginal Oil and Gas Production in Louisiana: An Empirical Examination of State Activities and Policy Mechanisms for Stimulating Additional Production

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Baton Rouge, LA
April 2004
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3 OVERVIEW OF OIL AND GAS ACTIVITIES IN LOUISIANA

3.1 Introduction

Oil and gas production has fallen significantly from the peaks of the early 1970s. Nevertheless, Louisiana oil and gas production is still considerable despite the fact that the nature and level of these trends have changed over the years. The following subsections highlight and discuss a number of descriptive statistics and empirical trends associated with overall Louisiana production.

3.2 Louisiana Jurisdictional Production

Figure 3.1 shows the number of active oil wells that have been operating in Louisiana jurisdictional areas since 1960. For purposes of this analysis, Louisiana jurisdictional areas are defined as the onshore and offshore areas that are directly regulated, for tax and royalty purposes, by the state of Louisiana. The activity associated with state oil wells follows four distinct trends over the past 30 years: the first period between 1960-1967; the second period between 1967-1979; the third period between 1979 to 1986; and the fourth period from 1986 to current.
During the first period, 1960 to 1967, the number of crude oil wells increased to an all time peak of 31,051 operating wells. From 1967 to 1979, operating oil wells began their first significant decline, to 20,898 operating wells – a level of which the industry had plateaued around for about five years. The industry got a second life during 1979-1986 when the number of operating oil wells increased by an annual average rate of about 3.4 percent. Since 1986, the number of operating oil wells has been in decline. Today, the total number of operating oil wells is about 61 percent of the state’s 1967 peak.

In 1960 operating oil and gas wells were close to evenly split between North and South Louisiana. Beginning in 1964, offshore oil wells (in state waters), began to come on-line. By the peak year (1967), over 15 percent of the state’s operating
oil wells were offshore (in state waters), with 46 percent and 39 percent in North and South Louisiana, respectively.

The relative share of active oil wells has changed more for South Louisiana, over time, than any of the other in-state production areas. The percent of South Louisiana wells fell consistently from 1970 (42 percent) to approximately 1990 where it has leveled off at 22 percent of all actively producing wells in the state. The share of wells in North Louisiana have followed an opposite pattern however, increasing steadily since 1970 from 53 percent of total to just under 75 percent of total in 1990. North Louisiana oil wells have remained around 75 percent of total for the last decade.

![Graph](image)

**Figure 3.2: Louisiana State Producing Natural Gas Wells**

Note: Offshore figures exclude federal OCS
Source: Louisiana Department of Natural Resources
Figure 3.2 provides a comparable historical analysis of trends for operating natural gas wells in Louisiana. Producing natural gas wells in the state have followed considerably different patterns than those of oil, owing in part to the considerable changes in regulation that have occurred over the past two decades in all aspects of the business (i.e., production, transmission, distribution, and sales). The number of natural gas wells increased gradually from 1960 until around 1978 at an average of 3.2 percent per year.

In 1978, the Natural Gas Policies Act was initiated to start the process of deregulating wellhead natural gas prices. Natural gas industry deregulation was considerably amplified in 1982 with the Natural Gas Wellhead Decontrol Act, and as a result, there was an exceptional increase in the number of active natural gas wells in Louisiana.

The number of active natural gas wells increased dramatically from 1980 until 1985: a period in which gas prices were reaching the relative high of $2.73 per Mcf. In the following year, the price of natural gas fell by about 16.9 percent (change from 1985 to 1986). Overall, by 1986, natural gas prices had fallen by 19.0 percent from its 1984 high and stayed relatively flat throughout the decade. As a result, the number of active natural gas wells decreased by almost 10 percent from 1986 to 2000.
In 2000, natural gas prices had their first meteoric rise, which had a noticeable impact in the number of active natural gas wells throughout the state. Active gas wells in North Louisiana, in fact, actually set a new peak in 2001 at 11,060 wells. The previous high for active North Louisiana wells was 11,049 in 1986. In addition, North Louisiana, over time, has seen its share of active gas wells increase. In 1960, North Louisiana accounted for 56 percent of all state active gas wells: that share increased to 82 percent by 2002.

Figure 3.3 shows historic crude oil production in Louisiana that has been graphed on two separate vertical axes. North Louisiana and jurisdictional offshore Louisiana production are graphed on the left-hand axis while South Louisiana production, because of its greater magnitude, is graphed on the right-hand axis. Oil production in South Louisiana accounts for roughly 72 percent of total state production while offshore and North Louisiana account for the remaining 28 percent. Generally, these shares have been constant since the 1960s.
All three series show that historically, overall crude oil production in the state has fallen considerably from peak production levels attained in the mid 1960s (North Louisiana) to early 1970s (offshore and South Louisiana). Today, crude oil production is 17 percent of its 1965 peak in North Louisiana, 12 percent of its 1970 peak in South Louisiana, and 12 percent of its 1972 peak in offshore Louisiana. Relative to their respective peaks, crude oil production in North Louisiana has experienced an annual average decline of almost 5 percent, with South Louisiana and offshore Louisiana each seeing a 6 percent average decrease per year.
Figure 3.4 shows average oil well production since 1960 for each of the three Louisiana regions. South Louisiana production per well peaked in 1971 at 38.2 thousand barrels per well (“Mbbls/w”) and has been declining at an annual average rate of almost 4 percent since that time. While clearly falling relative to its peak in 1971, South Louisiana oil well productivity was relatively constant between 1982 and 1999, hovering between 13 and 16 Mbbls/w. Oil well productivity in South Louisiana has also fallen considerably since 1999 (by over 26 percent).

Figure 3.4: Louisiana State Average Crude Oil Production per Well

Note: Offshore figures exclude federal OCS
Source: Louisiana Department of Natural Resources

Offshore Louisiana average oil production peaked one year after South Louisiana (1972) with a considerably higher level of production per well (62.2 bbls/w). However, unlike other regions of the state, average offshore oil production since
1982 has increased by about 2 percent per year until 1998. Within the last several years average offshore oil well productivity increased. By 1997 offshore average oil production had reached a level not seen since 1977.

Figure 3.5 shows historic natural gas production in Louisiana on two different axes. North Louisiana and offshore production have been graphed on the left-hand axis, while South Louisiana natural gas production has been graphed on the right-hand axis. The three areas of the state have followed two different trends. South Louisiana and offshore production have been decreasing since reaching their peak around 1970. Natural gas production in North Louisiana, while relatively small compared to other regions of the state (averaging 18 percent of total), has been slowly increasing since reaching its lowest point in the late 1970s.
Currently, South Louisiana natural gas production is 21 percent of its 1970 peak and offshore Louisiana production is 22 percent of its peak of the same year. South Louisiana gas production has been declining at a slightly faster average annual rate than the offshore region (4.6 percent versus 4.3 percent). Overall, South Louisiana production, while falling, still accounts for over 64 percent of total Louisiana jurisdictional production.

North Louisiana gas production has followed a very different pattern than the other two regions of the state. North Louisiana gas production peaked almost 30 years ago, in 1964, and decreased at an annual average rate of about 4.8 percent until 1979 (when it increased by almost 13 percent). However, since
1979 total natural gas production in North Louisiana, while up and down over various years, generally followed an increasing annual trend of about 1.6 percent until 1997. Since that time, natural gas production has been decreasing. By 2002, natural gas production was nearly 60 percent of the region’s all time peak.

Figure 3.6 shows historic natural gas well productivity for the three producing regions in Louisiana. All three regions have seen considerable decreases in average natural gas production (i.e., production per well) since its height of the early 1970s. Average production for offshore areas has fallen perhaps more dramatically than the other two regions. However, offshore gas production has seen a noticeable increase since 1993 when average gas production increased by 130 percent from 1993 to 1998. Average production for the offshore area has fallen by 26 percent since that period.
Natural gas production by well in South Louisiana has been relatively stable for the past twenty years. In 1983, natural gas production in South Louisiana averaged 385 MMcf per well. Average production today is slightly higher at 395 MMcf/well. Overall, average South Louisiana natural gas production is only about 35 percent of its peak in 1971, but has stayed close to this level for two decades.
4 EXAMINATION OF THE “TREADMILL” HYPOTHESIS FOR LOUISIANA PRODUCTION

4.1 Introduction

One explanation for the changing nature of gas markets has been that energy companies, both large and small, have been drilling and producing in the same areas for several decades. As such, these basins are becoming exhausted at a faster rate, and it takes virtually twice the effort to just stay in place. In other words, producers are on a virtual supply “treadmill” having to work harder and harder each year just to stay in place.

One detailed, state-level study that brought this hypothesis to the forefront was conducted by Simmons International, an energy industry investment banking firm headquartered in Houston, Texas. The original goal of the Simmons’ study was to test another widely reported “theory” about gas supply reactions following the natural gas price run-up of the winter of 2000-2001. This theory arose to explain what was perceived as an uncharacteristically and modest supply response following the 2000-2001 price run-up —despite the fact that there was a significant increase in drilling activity during the same period.

Many industry analysts attempted to explain the anemic supply response anomaly as production from “marginal” wells. The “marginal well” theory posited that producers rushed to develop a host of quick, marginal wells to take advantage of the price run-up and were not developing meaningful resources
during the period. If they had, the supply response would have been more considerable.

The Simmons study\(^7\) tested this “marginal well hypothesis” by examining a number of different types of wells across a 53 county sample in Texas. Contrary to the marginal well theory, the Simmons study found that wells drilled in reaction to the 2000-2001 price run up:

- Added about 8 billion cubic feet (“Bcf”) per day in supply;
- Had a profound impact on supply by accounting for about 30 percent of total Texas production;
- Instead of finding “marginal” wells, the study found quite the opposite:
  - Seven percent of 2001 wells accounted for 49 percent of 2001 production;
  - The remaining 93 percent of the active wells in Texas accounted for some 51 percent of total state production.
- The study found huge declines in post-peak year production of about 82 percent, a level considerably above historic trends;
- Had large new wells not been drilled in 2001, there would have been a serious supply crunch; and
- The remaining 93 percent of operational wells in the state, while not individually consequential, are collectively very important for holding up total state gas supply.

\(^7\)There is no directly citable “report” to reference for the Simmons study. This analysis has been given in a number of presentations by Matthew R. Simmons, President of Simmons International. One such presentation was before the Louisiana Comprehensive Energy Policy Commission. A number of versions of this presentation are available on the Simmons International webpage at: [http://www.simmonsco-intl.com/](http://www.simmonsco-intl.com/).
The most general and fundamental result of the Simmons study was that new drilling is important in maintaining gas supply, and that if drilling activities are not maintained, there could be considerable supply consequences.

This section of the report takes the methods applied in the Simmons study and applies them to Louisiana production data to determine if a treadmill-type phenomenon occurs in the state. This analysis is important for several reasons. First, if production is dropping off at ever increasing rates, it will have implications for any production forecast to determine future well profitability. Second, if production is falling off at a more rapid pace, it has implications for the development of marginal wells in the future. Third, for those wells that are individually producing at very small levels (the other “93 percent” referenced above), maintaining their economic viability will be important for state revenues.

The following subsections are a bit of a digression to examine this “treadmill hypothesis” using Louisiana, well-specific information. Production on all leases are examined first (oil and gas), followed by a comparable analysis for state leases.

4.2 Louisiana Production

Figure 4.1 provides an examination of overall historic Louisiana oil production. The area graph is color coded to highlight the contribution from various oil producing wells by year of completion. Production has been aggregated for the three producing areas of the state (North Louisiana, South Louisiana, offshore).
As seen from the figure, and highlighted in an earlier section of this report, oil production has been consistently decreasing since the late 1970s.\textsuperscript{8}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{oil_production_by_completion_year_all_luws.png}
\caption{Oil Production by Completion Year (all LUWs)}
\end{figure}

\textsuperscript{8}The data used in this analysis is based upon information reported to the Louisiana Department of Natural Resources. This information is collected electronically in the Production Area Reporting System (“PARS”) and made available (in part) through the SONRIS system. Both of these sets of information are described in greater detail in Section 2, however, this electronic information is reported at the operating unit of detail, and as a result, the earliest production year available in the PARS database is 1977. Hence, the difference in starting years (1977 versus 1960) for figures presented here, and those provided in Section 3.
Figure 4.2: Oil Production by Completion Year (all LUWs)

Figure 4.2 turns the production presented in Figure 4.1 into three-dimensions to highlight the contribution of each completion year to total Louisiana production. So, the purple series in the immediate foreground of the figure shows total annual production from all wells which reported a completion date of 1977. Likewise, the maroon curve immediately following the 1977 completion date production shows the annual production from wells completed in 1978. This progresses for each completion year available.

Two discernable trends are recognizable from both Figure 4.1 and Figure 4.2. As completion years become more contemporaneous:

(1) The absolute peaks in average production appear to be higher in overall magnitude; and
(2) The overall decline rates for production are becoming steeper.

In Figure 4.2, each of these trends can be seen by examining: (a) the “thickness” of the area towards the more recent completion years in the graph; and (b) the steeper slopes for curves in the more recent completion years.

Figure 4.3: Gas Production by Completion Year (all LUWs)

Similar trends are discernable in examining annual natural gas production. Figure 4.3 presents an annual two dimensional representation of annual Louisiana natural gas production. The areas in the graph that present production in the more recent completion years is much thicker than earlier years, indicating an increase in the average production, and overall contribution, that these wells are having on total Louisiana natural gas production. In addition, the steepness
of each of the curves are much greater than past completion years where declines took more traditional, exponentially decreasing trends.

Figure 4.4: Gas Production by Completion Year (all LUWs)

Figure 4.4 decomposes production from wells by their completion year and shows relatively high peaks coming from more contemporaneous natural gas wells. These peaks, and steep drop offs, appear to be more prevalent for wells completed since 1995.

Figure 4.5 offers a three dimensional presentation of average oil well productivity by completion year. This analysis is based upon data reported for individual
wells, and excludes production reported at the aggregate lease level.\textsuperscript{9} Three trends are discernable from the figure:

1) Average production peaks are much sharper as completion year becomes more contemporaneous.

2) The decline rate for newer oil wells is considerably steeper for wells completed more recently.

3) There has been a recent average production increase (or “blip”) for wells completed during 1977 to 1995 time period. This production increase began in 2000, and is probably attributable to operators re-entering older wells to expand production in response to the oil price increases in that year.

\textbf{Figure 4.5: Average Well Oil Production by Completion Year (single well LUWs)}

\textsuperscript{9}The method by which data is compiled by LDNR in its electronic databases is discussed in detail in Section 2. Multiple well information can be difficult to examine since there is no definitive way of allocating overall lease or unit production to a given well. Thus, this analysis focuses upon single-well reporting units only.
Figure 4.6 provides a comparable historic average production analysis for natural gas wells by completion year. This figure highlights the same three trends found for oil production, although somewhat more dramatic.

![Figure 4.6: Average Well Gas Production by Completion Year (single well LUWs)](image)

The last figure presented in the analysis appears to confirm the “treadmill” hypothesis. This figure examines average first year decline for all Louisiana producing wells by completion year. In other words, the decline in production one year after a well has peaked. Mathematically, peak year production decline is defined as:

\[
PYDR = \frac{q_{t+1}}{q_0}
\]

Where \( q_0 \) is peak production from a given well at any year \( t \) in its life, and \( q_{t+1} \) is the production one year after that peak level has been attained. In essence,
the formula defines the average first year decline as measured by the ratio of production one year after a well has peaked relative to overall peak production.

This relationship is a good indicator of how production is declining, on average, for wells that are completed in any given year. So, if a well with a completion date of 1977 has a peak year decline ratio (“PYDR”) of 0.90, then production is 90 percent of the prior year’s peak. If the PYDR is 0.70, then production in the year proceeding a well’s peak has fallen to 70 percent of the prior year’s level. The lower the ratio, the faster production has fallen one year after the peak. As noted earlier, the Simmons study of Texas leases found that recently completed wells were experiencing dramatic post-peak drop-offs in production.

![Figure 4.7: Production in the Year Following Peak Year (all LUWs)](image)

Figure 4.7 clearly shows that the trend in post-peak production from both oil and natural gas wells in Louisiana has been falling at an increasing rate since 1977, for both types of wells (oil, gas). The linear trends, which have also been plotted on the figure, show that the post peak drop-offs for natural gas wells in Louisiana,
which were at about the 95 percent level in 1977, have fallen to around 62 percent in 2001. Oil wells, on the other hand, have seen their post peak production decrease from 89 percent in 1977 to 68 percent by 2001. Overall the gas decline rate appears to be decreasing at a much faster rate than oil.

4.3 State Lease Production

State leases were also examined to determine if the trends noted above at the overall state production level existed at the state lease level as well (i.e., increased average production, increasing decline curves). Annual oil production from state leases, by well completion year, has been presented in Figure 4.8. Like the figures from overall state production, increasing volumes are discernable from wells completed since 2000. One noticeable difference in the state lease trends is that the peak oil production increases occur only recently (since about 2000). The overall state trends showed these increases occurring as early as 1995.
The recent increase in peak oil production on state leases is shown more clearly on Figure 4.9 which is a three-dimensional representation of state lease production by completion year. Production in years 2000 and 2001 take a noticeable spike that is considerably different, and higher, than prior years’ production trends.

Figure 4.9: Oil Production by Completion Year (all LUWs)

Figure 4.10 presents the two-dimensional graph for natural gas production on state leases by completion year. Increases in peak gas production start initially around 1995, fall off, and pick up again in 2000. The trends in gas production peaks on state leases are much more consistent with overall state trends than oil
production. The trend of increasing peak gas production is seen clearly from the three-dimensional representation provided in Figure 4.11.

Figure 4.10: Gas Production by Completion Year (all LUWs)
Average oil and gas well production have been presented in Figure 4.12 and Figure 4.13. Both figures highlight a number of the same trends found in the examination of the statewide totals that include: (a) higher peak production; (b) faster decline rates; and (c) increases in production from recently completed wells.
Figure 4.12: Average Well Oil Production by Completion Year (single well LUWs)

Figure 4.13: Average Well Gas Production by Completion Year (single well LUWs)
Figure 4.14 examines the linear trends in the declines of oil and gas production on state leases by well completion year. Trends are comparable to overall state production, with a few exceptions. Based on the overall trend analysis, post peak production ratios for oil production starts at around 91 percent in 1977, and declines to a level of around 79 percent for 2002. For natural gas, post peak production ratios start at around 98 percent in 1977, and fall to 71 percent by 2002. The average annual decrease is much steeper for natural gas than oil. The post peak production ratios for state leases are slightly more tempered than those for overall state production. This is particularly true for oil production. Nevertheless, there is a noticeable decrease in the post peak production trends for state leases, and it is noticeably steep for natural gas production in particular.

Figure 4.14: Production in the Year Following Peak Year (all LUWs)