All the DUCs in a Row: Natural Gas Production in the US.

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Introduction

- Significance of natural gas industry for the US economic activity
- Suitability of rig count as the determinant of natural gas production has been questioned (EIA 2013)
- Market analysts, researchers and government agencies have noted the increase in the inventory of drilled but uncompleted (DUC) wells in the US (EIA 2013; Srinivasan, Krishnamurthy and Kaufman, 2019; IHS, 2016).
- A clear understanding of natural gas production patterns is important for economic planning, policy decisions, and market analysis (Kaiser and Yu, 2012; Weber 2012).

Objectives

- To examine the impacts of DUC well inventories, drilling rig activity, and producing well counts on US natural gas production.

a. To examine the role of well completion rates in explaining natural gas production.

b. To examine the determinants of DUC well numbers, which represent the gap between drilled and completed wells.

c. To identify the factors that influence the length of time that operators take to complete unconventional wells.

Data

- We use monthly data from 2007 to 2018 for the analyses of natural gas production, and from 2000 to 2018 for the analyses of DUC counts and duration. Data from EIA and DrillingInfo.

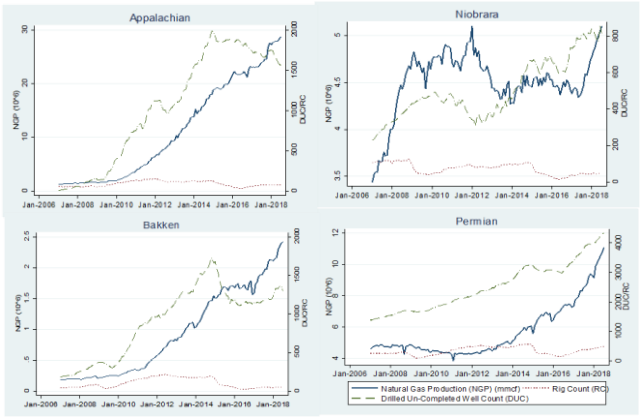

Fig 1. Rig Count, Drilled and Un-Completed Well Count, and Natural Gas Production Trends from 2007-2018

Estimation Strategy

a. Linear regression analysis of natural gas production in terms of rig counts and producing wells.

b. Analysis of DUC well counts within and across regions using regional fixed with or without time fixed effects

c. Analysis of individual well DUC duration status using survival analysis models.

- t (in days) to represent DUC duration
- the hazard rate ($\lambda(t)=f(t)/S(t)$) -is the probability that a drilled well will be completed at time, t.
- we use semi-parametric Cox proportional hazard model (Cox, 1972)

Results: Analysis of Natural Gas Production

Table 1: Split Sample Regional Fixed Effects Regression Results

Dependent – NGP	Before Feb 2009	After Feb 2009
Rig Count$_{t-1}$	0.212 (0.04)***	-0.057 (0.03)
Constant	13.552 (0.17)***	15.589 (0.15)***
R-sq	0.17	0.010

*Note: Significant Values 1%***, 5%**, 10%*; Standard Errors in Brackets*

Table 2: Region Fixed Effects Regression Results

NGP-Dep	Model 1	Model 2	Model 3
Rig Count$_{t-1}$	0.067 (0.03)**		0.073 (0.02)***
Producing Wells		0.817 (0.04)***	0.826 (0.03)***
Feb 2009	0.765 (0.04)***	0.187 (0.04)***	0.186 (0.04)***
Constant	14.23 (0.15)***	7.251 (0.33)***	6.823 (0.35)***
R-sq	0.245	0.503	0.507

*Note: Significant Values 1%***, 5%**, 10%*; Standard Errors in Brackets; Data from 2007-2018*

Results: Analysis of DUC well counts

Table 3: Drilled and Un-Completed Well Analysis Regional Results

	Region fixed effects	Region and Time Fixed Effects		
DUC - dependent	A. Log-log	B. Log-log with ΔPipeline Capacity	C. Standardized across regions	D. Standardized by region
Pipeline Capacity	-0.302 (0.04)***	2.274 (1.73)	0.329 (0.17)	0.232 (0.24)
Rig Count$_{t-1}$	0.704 (0.03)***	0.585 (0.14)***	0.485 (0.11)***	0.412 (0.09)***
NG Future Price	-0.276 (0.06)***	-2.337 (0.69)**	-0.636 (0.16)***	-1.493 (0.73)*
Oil Future Price	-0.249 (0.05)***	-4.112 (1.01)***	-0.765 (0.16)***	-1.841 (0.86)*
Time	0.011 (0.00)***			
Constant	5.488 (0.24)***	24.34 (4.48)***	-0.218 (0.13)	-1.008 (0.39)**
Adj R-sq	0.785	0.735	0.792	0.721
Observations	966	966	966	966

*Note: Significant Values 1%***, 5%**, 10%*; Robust Standard Errors in Brackets; Data from 2007-2018*

Results: Analysis of DUC duration

Table 4: UOG DUC Duration Analysis Results

Variables	Generalized linear model	Semi-Parametric Cox Proportional Model	
Dep-DUC Duration	A. Coef.	B. Coef.	C. Hazard Ratio
LL	-139760	-1346626	-1401168
LR Chi2(12)		20062 (0.00)	20062 (0.00)
NG Future Price	-0.041 (0.01)***	0.052 (0.01)***	1.053 (0.01)**
Oil Future Price	-0.051 (0.01)***	0.118 (0.01)***	1.126 (0.01)***
Pipeline Capacity	-0.502 (0.03)***	1.013 (0.05)***	2.753 (0.13)***
Gas Well	0.232 (0.01)***	-0.269 (0.01)***	0.764 (0.01)***
Well Measured Depth	0.498 (0.01)***	-0.350 (0.01)***	0.705 (0.00)***
Time	0.0001(0.00)***	-0.0002(0.00)***	0.999 (0.00)***
Appalachia	1.477 (0.03)***	-1.960 (0.04)***	0.141 (0.01)***
Bakken	-0.320 (0.03)***	0.651 (0.04)***	1.917 (0.08)***
Eagle Ford	-0.225 (0.03)***	0.594 (0.05)***	1.811 (0.09)***
Haynesville	0.544 (0.03)***	-1.061 (0.04)***	0.346 (0.02)***
Niobrara	0.621 (0.01)***	-0.869 (0.02)***	0.419 (0.01)***
Permian	0.288 (0.01)***	-0.411 (0.01)***	0.663 (0.01)***
Observations	126,048	127,627	127,627
Number of Completions	126,048	126,048	126,048

*Note: Significant Values 1%***, 5%**, 10%*; Standard Errors in Brackets; Data from 2000-2018*

Conclusion

- As part of the producing wells, new wells and completion of drilled wells are important factors of natural gas production.
- The decline in the importance of rig counts as a determinant is expected given the nature of UOG production technology where extraction begins following well completion.
- The survival results confirm the effect of pipeline infrastructure bottlenecks in natural gas markets.

References

- Cox, D. R. (1972). Regression models and life-tables. Journal of the Royal Statistical Society: Series B (Methodological), 34(2), 187-202.
- EIA. (2013). Rethinking rig count as a predictor of natural gas production. Today in Energy. https://www.eia.gov/todayinenergy/detail.php?id=13551. Accessed 11/06/2018.
- IHS (2016). Oil and Gas Operators with Significant Inventory of Drilled but Uncompleted Wells in Major U.S. Plays to Benefit from Capital Efficiency Gains in 2016. https://news.ihsmarkit.com/press-release/ducs/oil-and-gas-operators-significant-inventory-drilled-uncompleted-wells-major-us-pl. Accessed 4/18/2019.
- Kaiser, M. J., & Yu, Y. (2012). A scenario-based hydrocarbon production forecast for Louisiana. Natural resources research, 21(1), 143-162.
- Srinivasan, K., Krishnamurthy, J., & Kaufman, P. (2019). Concerns and Clarifications for Drilled Uncompleted (DUC) Wells in the Williston Basin. SPE Reservoir Evaluation & Engineering. Society of Petroleum Engineers. Vol 22 Issue 01. DOI: https://doi.org/10.2118/185753-PA.
- Weber, J.G., 2012. The effects of a natural gas boom on employment and income in Colorado, Texas, and Wyoming. Energy Economics, 34(5), pp.1580-1588.