TECHNICAL EFFICIENCY AMONG GAS PRODUCERS IN THE BARNETT SHALE PLAY

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Overview

Gas production from shale plays like the Barnett has greatly reinvigorated the United States' supply of gas from domestic sources. Published studies and reports showing the transformative impact that shale gas production has had on the United States, as well as global, energy markets are widespread. Barnett shale formation has the longest production history among all the shale formations in the United States and it used to have the largest share of shale gas produced each year until it was recently surpassed by the Haynesville play. For the most part of the Barnett's producing years, production was minimal. It was only during the mid-2000s that the pace of well drilling and gas production picked up significantly and by 2011, more than 15,000 wells had been drilled in the Barnett compared to only around 4000 by the end of 2004. Between 1982 and 2011, the number of gas companies that had drilled at least one well in the Barnett was about 250, after accounting for acquisitions. Gas production rates from wells have varied with time as the use of horizontal drilling gained momentum and wells' lateral lengths grew longer over time. Production rates have also varied among operators. Although geologic characteristics of shale reservoirs are important determinants of the quantity of gas that can be produced, they are not definitive. Gas producers' ability to access the gas also plays an integral role in how much output is ultimately extracted. Given similar formation characteristics, producers differ in the amount of gas extracted due to differing drilling and completion practices. This paper is an attempt to study these discrepancies and estimate technical efficiency among the gas producers in the Barnett.

Methods

The analysis uses both stochastic frontier analysis (SFA) and data envelopment analysis (DEA) methods to estimate technical efficiency among operators for wells that began production during 2001-2010. Although the unit of interest for efficiency estimates is operators, the data envelopment and stochastic frontier analyses are done at the well level with each operator-well pair taken as a decision-making unit. Operator level efficiency scores are then calculated from efficiency estimates of the wells they own. The reason for conducting the analysis at the well level is because of the presence of non-discretionary well-specific geologic characteristics, which cannot justifiably be aggregated up at the operator level. Moreover, some operators might use varying sand type mixtures when fracturing different wells they own or hire different drilling companies for their wells. Examining how these variables and others affect technical efficiency requires using the micro level data. In addition to these two techniques, multilevel modelling (MLM) is also used to estimate operator effects in a more direct way. Unlike data envelopment and stochastic frontier analyses, multilevel modeling is not a frontier technique – instead it estimates the average production function for a given dataset. Multilevel modeling is appropriate for determining how effective operators are at producing gas using available inputs and given intrinsic well characteristics because it incorporates the hierarchical structure of the sample data which results from the fact that wells are nested within operators. The output considered in this analysis is cumulative gas production from each well's first six months of production. Input variables are each well's length, volume of hydraulic fracturing fluid, and quantity of sand (proppant) used during completion. Also controlled for in the analysis, are each well's geologic characteristics and county location. Production and hydraulic fracturing materials data was obtained from IHS and DrillingInfo while wells' geologic characteristics were estimated by a team at the Bureau of Economic Geology at the University of Texas – Austin.

Results

Preliminary analysis was done for wells that began production during 2009-2010. All the geologic variables used in the analysis – porosity, pressure, thermal maturity, and thickness – are positively correlated with production, with the coefficients for pressure and thickness being significant at the 1% significance level. Coefficients for well length, fracturing fluid and proppant variables are also highly significant and all positively correlated with production in the stochastic frontier analysis and multilevel modelling regressions. Operators with the largest (positive) group effects in the MLM analysis include seven small operators that achieved highest average and median SFA efficiency scores. These are Adkins, Bagby, Crown, Cumming, Eagleridge, Vargas and Western Chief. None of the large operators, Chesapeake, Devon, EOG, Quicksilver, and XTO, are ranked highly using either the MLM group effects or DEA and SFA average/median efficiency scores. When operators are ranked using the maximum SFA efficiency score statistic, all the large operators are among the top 10 highly ranked operators. The rest of the top 10 spots are occupied by Crown, Cumming, Eagleridge, Vargas, and Range.

Conclusions

Analysis results for wells that began producing gas during 2009-2010 indicate that small companies are among the most technically efficient producers in the Barnett Shale play. However, there is great variation in efficiency among small operators because the lowest ranked spots are also occupied by operators that fall in this category. More work will be done to analyse the differences in efficiency estimates between small and large operators. In addition, hydraulic fracturing data is still being collected for wells that began producing in periods preceding 2009-2010. A longer time series will be able to shed more light on the issues studied.