

Effects of Ownership and Business Portfolio on Production in the Oil and Gas Industry

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Executive summary

The Shale Revolution and high volatility in oil prices (especially in 2008 and 2014) have overwhelmingly reconstructed the petroleum industry in the last decade. These events not only significantly affected productivity but also overwhelmingly reshaped the production process of the industry. As a result, the shape of the production function may be time-variant. Moreover, heterogeneity across companies is also a big concern as many multi-product (oil and gas) and multi-segment (upstream and downstream) firms exist, both state-owned and privately-owned. Since different segments and products involve different technologies, and companies with different ownerships are found to be completely distinct, each has its own production process and input–output relation.

To summarize, both ownership and business portfolio, along with time, can influence the production function. The first puzzle is that the classic method assumes the shape of the production function is fixed, which fails to capture the varying input–output relation over time and across firms. To solve this issue, this paper employs a varying production function to better estimate the true data-generating process, where the production function not only can shift, as in the classic model, but can also be reshaped depending on the aforementioned factors. Although the varying coefficient model captures the heterogeneity in time, ownership, and business portfolio, their effects are modeled nonparametrically and are therefore hard to clarify. This second problem motivates us to further decompose input elasticities and total factor productivity using a second-step parametric regression, so that their impacts can be better interpreted.

Three central contributions are made in this paper. First, a varying coefficient method is used to better capture the fundamental transition of the petroleum industry over the past decade. Second, this study extends the comparison between National Oil Companies (NOCs) and privately-owned International Oil Companies (IOCs) in literature by not only interpreting more accurate effect of ownership on productivity than was estimated with bias, but also investigating its impacts on the input–output relation that was overlooked. Third, this paper also controls the heterogeneity in segment-wide and product-wide business portfolios and predicts their effects on production, which contributes to the studies of multi-product, multi-segment and multidivisional firms.

Using panel data from 110 of the largest oil and gas companies from 2009–2016, the empirical results show that labor elasticity was increasing, elasticities of oil and gas reserves were decreasing, and refinery elasticity was relatively flat. The changes in the productivity of these petroleum giants follows the business cycle, which achieved tremendous growth after the 2007–2009 financial crisis but lost momentum following the oil price crash since the end of 2014. Furthermore, segment-wide and product-wide portfolios, as well as ownership, significantly affect the input elasticities and therefore the shape of the production frontier, which in turn confirms the importance and necessity of employing the varying coefficient model, rather than the classic model. Finally, IOCs, gas production and downstream activities, *ceteris paribus*, are more productive than NOCs, oil production and upstream activities, respectively.

The empirical results deliver the following policy implications: 1) the government should be very careful in putting pressure on NOCs to fulfill their non-commercial objectives; 2) privatizing NOCs may be a good option to prevent shortage in oil and gas supply and higher energy prices; and 3) oil companies can hire more oilfield service companies to explore and produce oil and gas.

Keywords: Stochastic Frontier Analysis; Varying Coefficient Model; Oil and Gas Industry; Effects of State Ownership; Segment-wide and Product-wide Business Portfolio.

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