A METHODOLOGICAL FRAMEWORK FOR THE ESTIMATION OF UNCONVENTIONAL GAS DEVELOPMENT COSTS; ACCOUNTING FOR THE IMPACT OF PETROLEUM PRICE UNCERTAINTY

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Overview

Hydrocarbon from unconventional sources are considered to have higher development cost; as such a drop in oil and gas prices could lead to supply strain from these natural resources. Furthermore different unconventional sources, regions, fields and wells have heterogeneous characteristics that determine cost trends. This paper conducts a disaggregated empirical cost analysis for unconventional shale gas development, develops cost equations for development activities as well as cost correlation relationships to address uncertainty due to fluctuation in petroleum prices

Methods

Natural gas drilling activity is analysed globally, within the United States, Europe and the United Kingdom; drilling activity data is analysed against oil and gas prices. Completion, hydraulic fracturing, operations, maintenance and decommissioning cost are appraised via disaggregated cost data on a per well basis. Furthermore a theoretical framework is developed based on cost estimation and uncertainty incorporation. A bottom up cost estimation model is developed for drilling and completion based on work breakdown structure which accounts for geological properties and reservoir depth. Additionally the uncertainty model focuses on the impact of changes in petroleum prices by developing a regression model which estimates the effect of changes in petroleum prices to major cost determinants in unconventional gas development. The study applies empirical data related to development cost subdivided into; drilling, hydraulic fracturing, and completions. Cost determinants are identified for these development stages; time series prices and indexes provide basis for a regression analysis which estimates historical correlation between the cost determinants and petroleum prices.

Results

An unconventional gas development cost model is developed based on a per well analysis. The following cost estimation equations are proposed based on bottom up workbreakdown analysis:

Drilling: Σ(RMR + DC+ ((RD/RoP)*RDR) + CCdepth * trips…Equation 1

Completions: WHC+SU/depth*depth*SCdepth…..Equation 2

Other Variables: O & M, Waste Management & Decommissioning.

Fiscal regimes and regulatory costs are not considered in this study.

Empirical data from a shale play in the United States indicates drilling costs are driven by both Rig rental & Casing costs while completion and hydraulic fracturing is driven by mainly stimulation & sand control costs. The results from the disaggregated well cost data analysis suggests that during completion, stimulation sand control costs are 58% of total costs and 30% of overall costs.

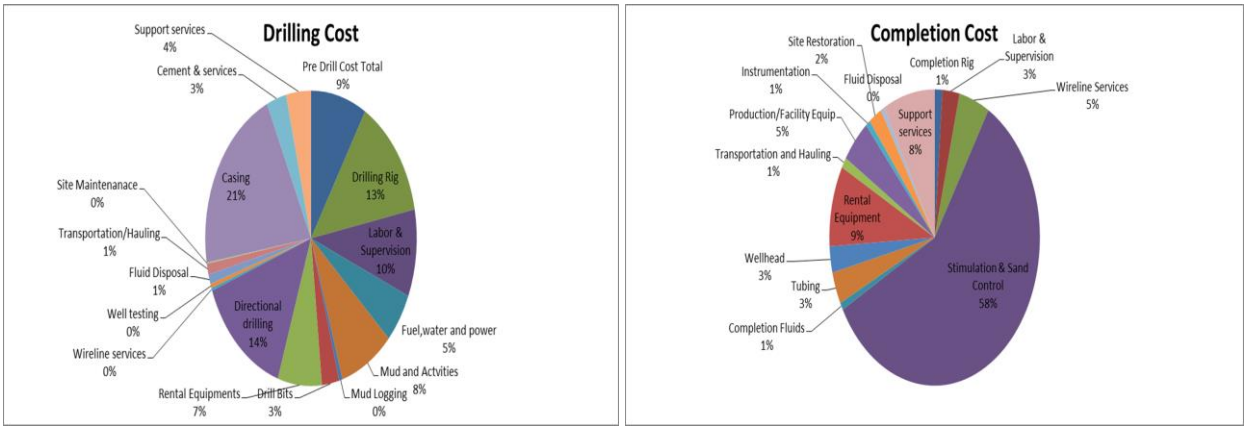

Figure 1:Disaggergated Analysis of Drilling and Completion Cost Components

Simulation sand producer's price index provides time series data regressed against petroleum prices results in the estimated response and relationship between simulation sand demand and petroleum price uncertainty as well as the impact ondevelopment cost. Consequently onshore horizontal and vertical drilling actvicity indexes are examined in relation to historical petroleum prices. Finally the impact of uncertainty in petreoleum prices on steel prices used in casings. The regression model results reveal correlation as well as the impact of a unit increase in petroleum prices on vertical and horizontal drilling , steel used for casing and simulation sands applied in completion operations.

Simulation Sand Demand=101.46+1.86Oilprice (R^2=0.89)……Equation 3

Horizontal Rig Demand=(-184.72)+11.14Oilprice (R^2=0.92)…….Equation 4

Vertical Rig Demand= 616.98+ 0.14Oilprice (R^2=0.002)…….Equation 5

Steel Demand Index= 92.90+1.4310Oilprice(R^2=0.97)……Equation 6

*Exclusive of standard error terms

Conclusions

(1) The established theoretical framework can be used in undeveloped unconventional gas play cost estimation and hence economic and commercial appraisal.

(2) The results suggest horizontal drilling, steel and simulation demand are highly correlated with historical petroleum prices.

(3) The demand for vertical drilling implies insignificant correlation with oil prices based on the data and approach.

(4) Additional the cost uncertainty modelling approach with a focus on the impact of petroleum prices incorporates the relationship between oil prices and cost in the industry.

(5) These results could guide policy makers on oil price fluctuation impact mitigation in unconventional gas development and its value chain.

(6) Finally the empirical evidence can be incorporated into development cost modelling of unconventional gas resources.

References

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