Oil & Gas Exploration:
Phase 1

Simulation & Risk
Dr. Aric LeBarr

Orange Team 2
Qing Feng, Andrew Moolenaar, Carlos Chávez, Julie Huang, Bill Jenista

Executive Summary

Our goal is to simulate future values of 2019 drilling costs and provide a recommendation of the simulation method to the department of Price Analysis in Compagnie Pétrolière et Gazière, INC (the "Company"). The two simulations our team created have created resulted in similar cost distributions with few differences. Additionally, both of them suggest that the expected 2019 drilling costs will be higher than those in 2006.

After comparing the two simulations, we recommend the department of Price Analysis adopt the simulation using the kernel density estimate mainly for two reasons: 1. It is more conservative in terms of having higher costs in the right side of the distribution. 2. It does not assume a distribution and would work even if the data were not normally distributed (Figure 1).

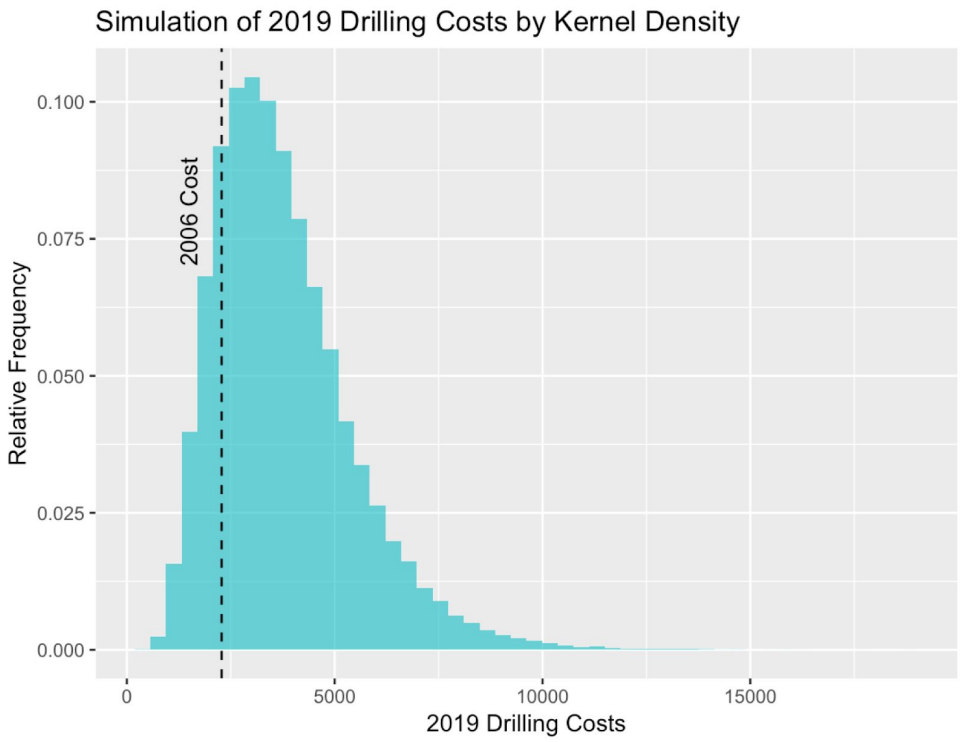


Figure 1. Simulation of 2019 Drilling Costs by Kernel Density Estimate

Background

Per RFP SR-F3.H1, we utilized the historical drilling cost data provided by the Company to simulate possible future values of 2019 drilling costs. As per the recommendations of the Company's department of Price Analysis, we limited the data used to the years 1990 to 2006, excluding years prior to 1990 due to tremendous changes in the industry over the decades. Year 2007 was also excluded as an outlier. Finally, the Company's analysts advised treating the oil, gas, and dry wells equally and that average changes in cost apply to them all.

According to information from a recent report from the U.S. Energy Information Association included in the RFP, we were able to use the provided arithmetic changes in drilling costs to simulate the arithmetic changes in cost from 2006 to 2019. In particular, the changes from 2006 to 2012 were relatively consistent in their distribution exhibited from 1991 to 2006. We will address the Company's assumption that this distribution was Normal.

Analysis & Results

We conducted two simulations of 100,000 iterations each. The first simulation (Simulation 1) assumed a Normal distribution for the 2006 to 2012 time period while the second (Simulation 2) used kernel density estimation to build a distribution directly from the 1991 to 2006 data. Both simulations utilized two triangular distributions for the 2012 to 2015 and 2015 to 2019 time periods. The simulation output, the arithmetic changes from 2006 to 2019, were applied to the average drilling cost (Figure 2) as well as the crude oil, natural gas, and dry well costs individually.

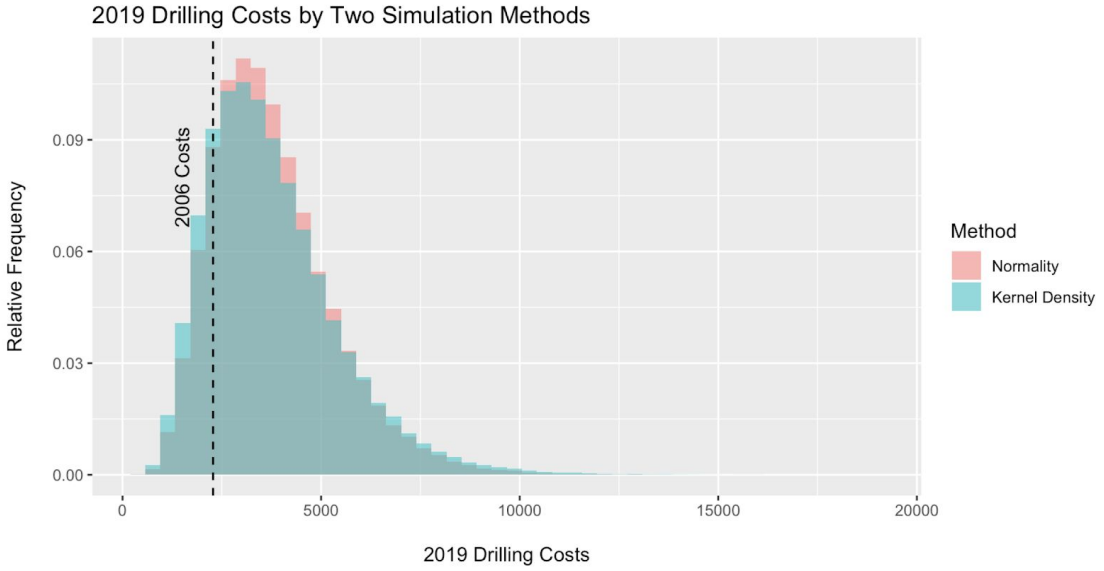


Figure 2. 2019 Drilling Costs by Two Simulation Methods

As can be seen in Figures 1, there is not much difference between the two simulations. We can see that the expected costs for 2019 will be greater than the 2006 costs for either simulation. Further investigation of the 5th and 95th percentiles (Table 1), shows that Simulation 2 has the lower 5th percentile but the higher 95th percentile. This means that Simulation 2 has greater variance than Simulation 1. Therefore, we recommend using Simulation 2 because it is more conservative, and it does not assume a distribution for the 2006 to 2012 period. Thus, it is the more flexible approach.

	Normality Simulation		Kernel Density Estimate Simulation	
Drilling Cost ($1,000/well)	5th Percentile	95th Percentile	5th Percentile	95th Percentile
Average	1756	6598	1638	6878
Crude Oil	1724	6479	1608	6754
Natural Gas	1491	5604	1391	5842
Dry	2052	7712	1914	8039

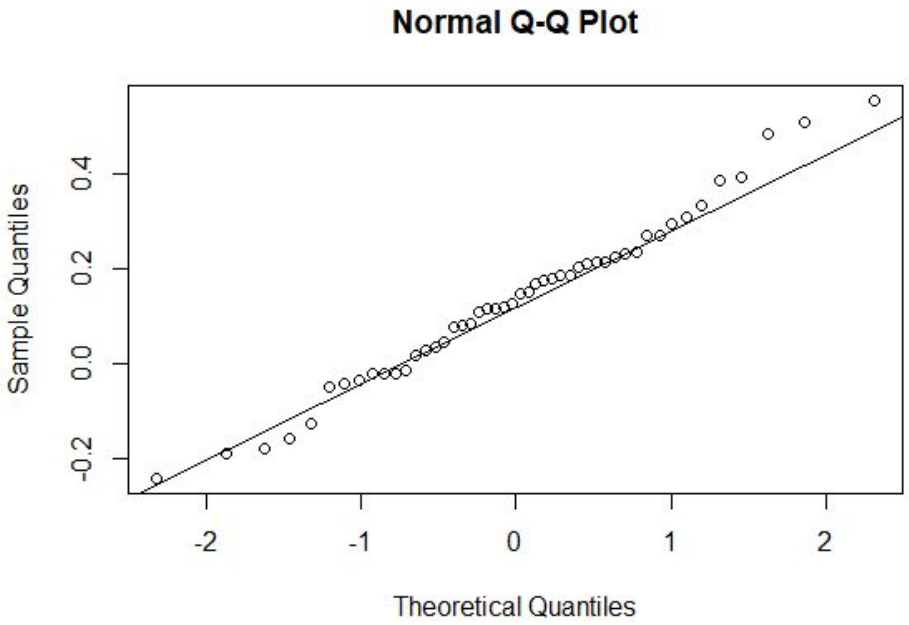
Table 1. 5th and 95th Percentiles of Simulation 1 and Simulation 2

In order to check the Company's assumption that the distribution of arithmetic changes from 2006 to 2012 is Normal, we plotted the 1991 to 2006 data on a Normal QQ Plot. As can be seen from the plot in the appendix, the Company's assumption of a Normal distribution is acceptable; however, we still recommend using simulation 2 as is does not assume a distribution and would work even if the data was not Normal.

Conclusion

Based on our analysis, we suggest using the kernel density estimate simulation because it is conservative as well as no assumptions of normality are needed. Considering drilling costs of the three different well types might vary, we recommend calculating arithmetic changes separately and using a similar simulation method to get a more detailed estimate of 2019 drilling costs.

Appendix



Appendix 1. Normal Q-Q Plot