



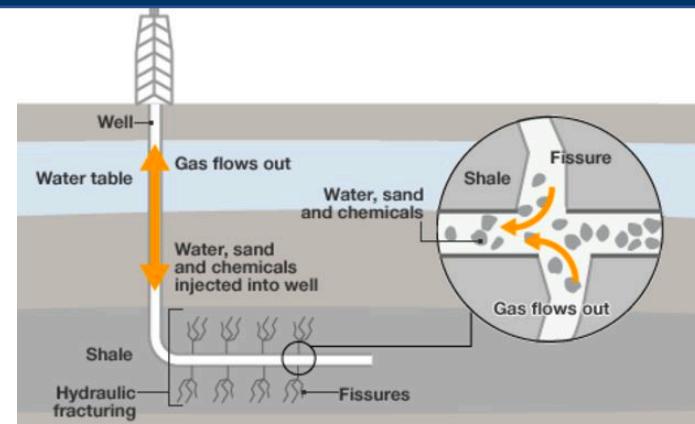
Completion Uplift: The Impact of Completion Design on Well Performance

Alexander Parker
July 19, 2019

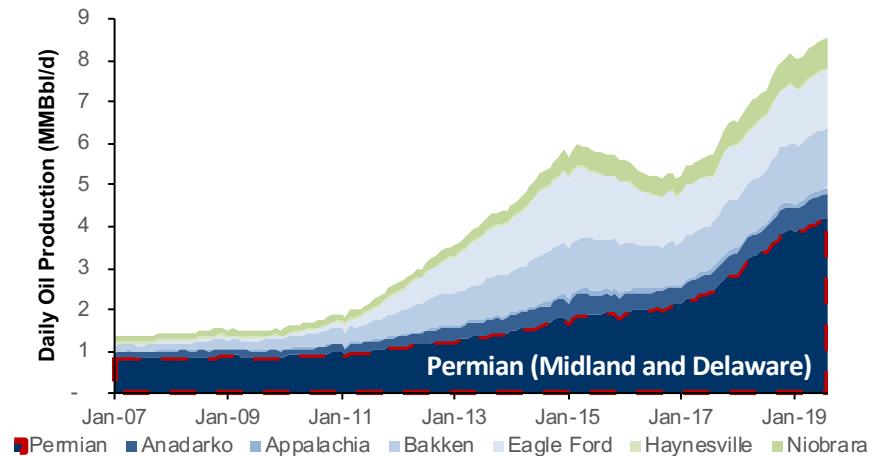
A Quick Overview

- U.S. domestic oil production has grown significantly due to two technologies:
 - Horizontal Drilling
 - Hydraulic Fracturing
- Onshore development has been concentrated in tight shale formations:
 - Midland Basin
 - Delaware Basin
 - Eagle Ford
 - SCOOP/STACK
- Operators “complete” wells with a mixture of sand, water and chemicals to create and maintain fissures in the shale

Hydraulic Fracturing Diagram



Daily U.S. Production by Region

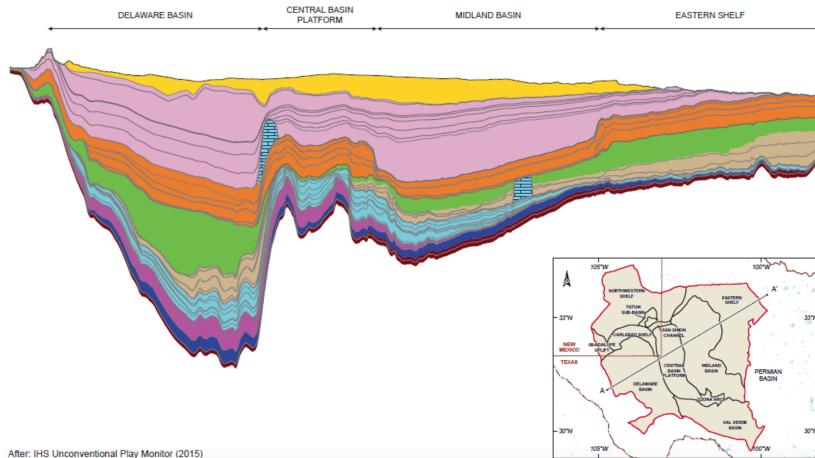


Source: BBC (Top), EIA Drilling Report (Bottom).

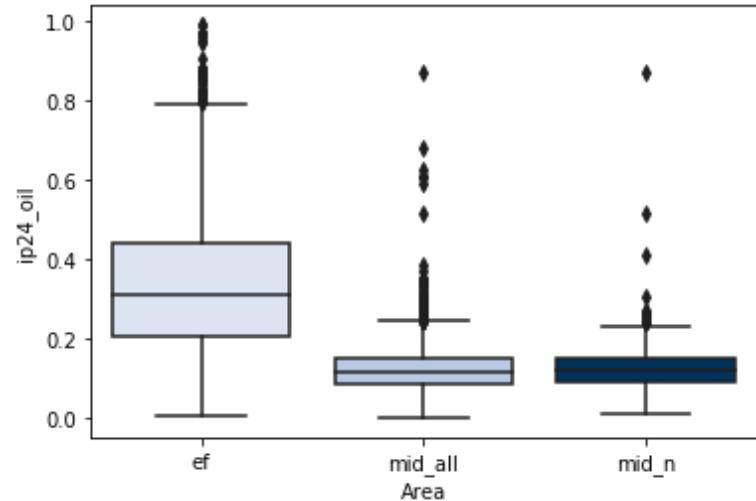
Structuring the Question

- Question: What completion designs provide the best improvement to a well's initial production?
- Underlying rock quality and completion design are the main drivers of well performance
- *However, completions can only improve the recovery factor (% of theoretical oil in the ground) of a given well, so performance is ultimately limited by rock quality*

Permian Geologic Cross-Section



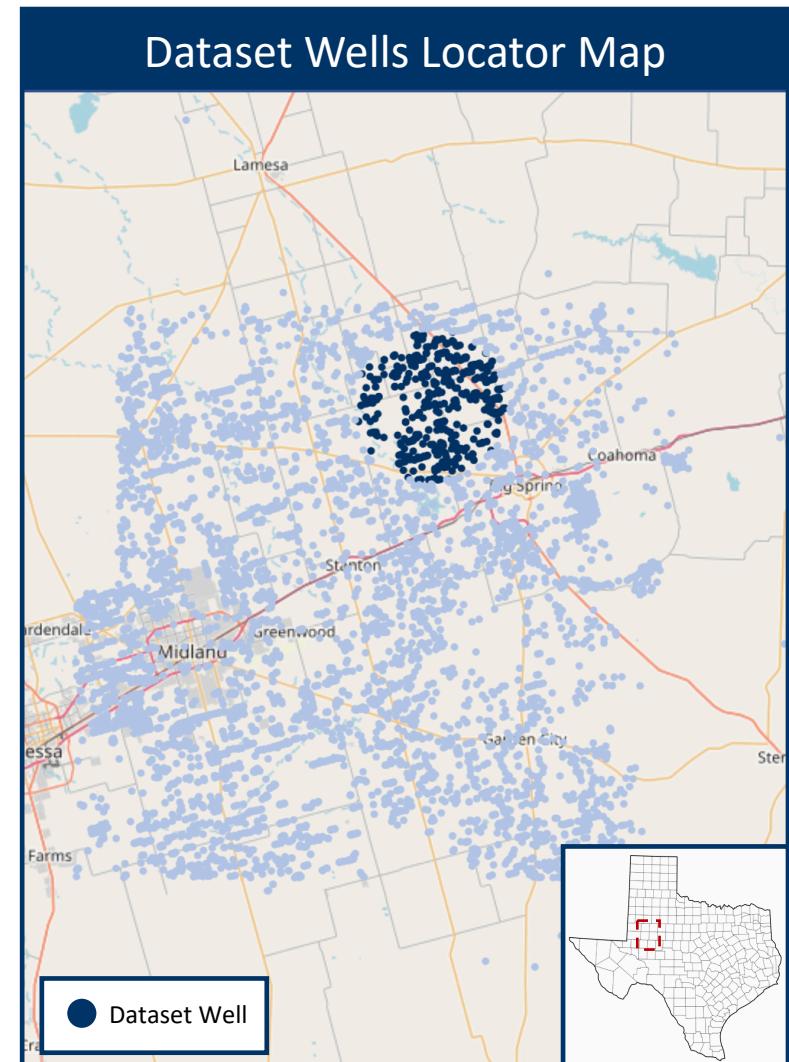
Oil IP24/ft by Area



Source: IHS Markit (Left).

Data and Feature Selection

- Data collected from two main sources:
 - Texas Rail Road Commission Completion Queries (Form W-2 PDFs)
 - Initial 24 hour oil, water and gas rates
 - Lateral length
 - Completion pressure
 - FracFocus Chemical Disclosure Registry
 - Sand
 - Water
 - Pressure
 - Chemicals
- Well selection was subject to data availability and ultimately limited to northern Midland county

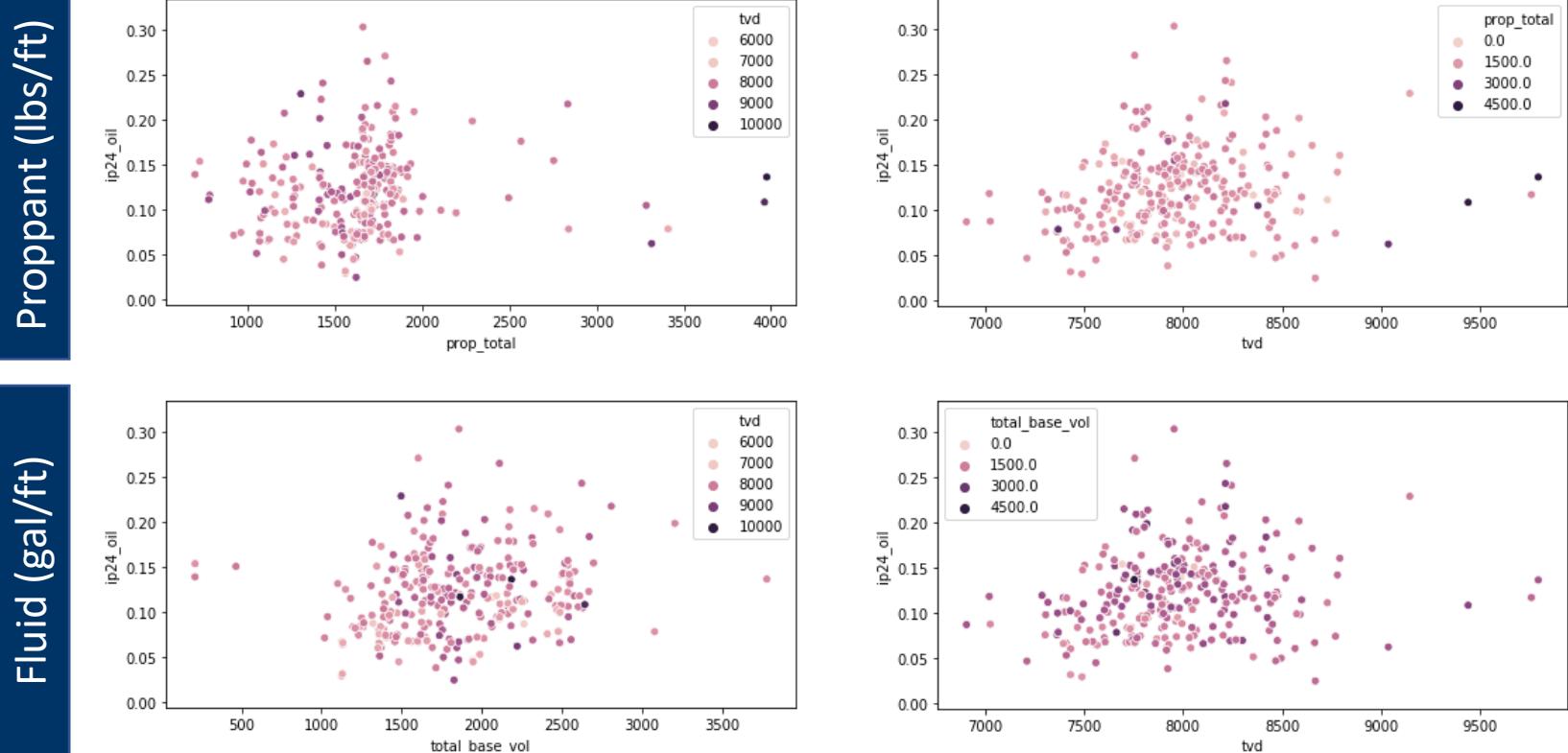


Target and Feature Analysis

- Completion intensity was not highly correlated with oil rate, even when depth / geologic differences were considered

X: Completion Spec; Color: TVD

X: TVD ; Color: Completion Spec



Model and Feature Analysis

- BOE IP24/ft was modelled using a ridge regression after outlier cleaning and removal of poor-performing features
 - Testing R²: 0.169
 - Training R²: 0.229
- Overfitting was a significant problem, likely due to poor data quality and the inability to account for rock quality
- Lasso regression used to remove poor predictor features
 - ~1/2 of features were removed
- Strong Positive Features:
 - Total Vertical Depth
 - Resin Coated Sand
 - Friction Reducers
 - Total Base Liquid Volume
- Strong Negative Features:
 - Gel
 - Gas Lift
 - Lateral Length
 - Percent Water Volume